MECHANICAL ENGINEERING

July, 1958

Equipment for the Stationary Gas Turbine

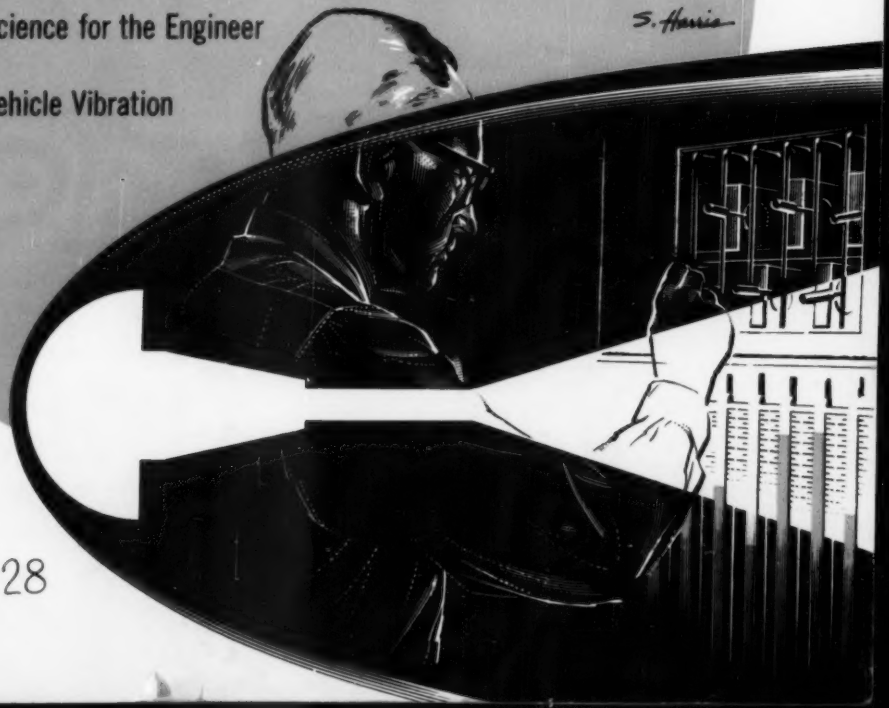
Selecting Flight Test Instrumentation

Research and Higher Education

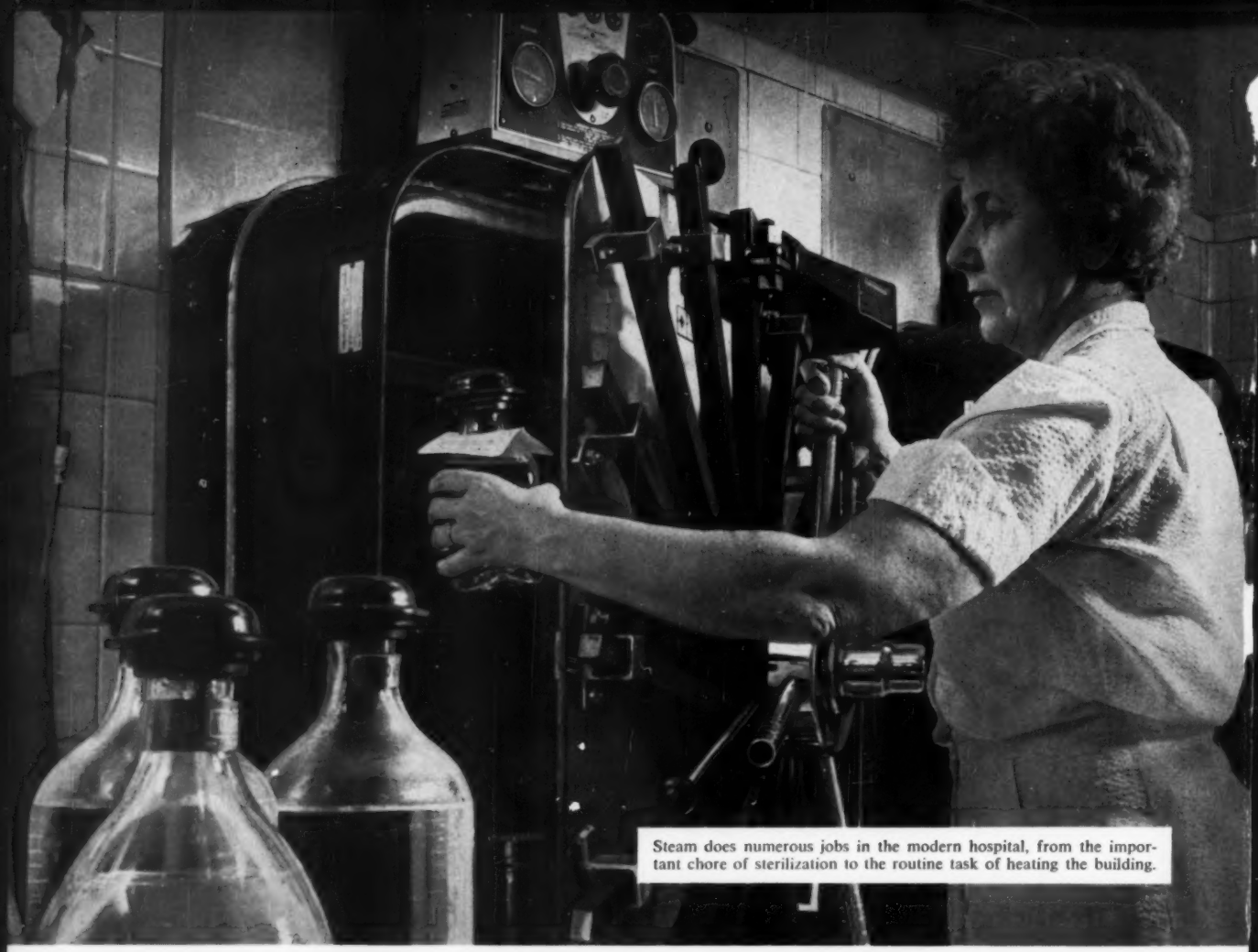
Teaching Creative Engineering

Science for the Engineer

Vehicle Vibration



Helium Shock Wave-Mach 28



Steam does numerous jobs in the modern hospital, from the important chore of sterilization to the routine task of heating the building.

Steam Supply by B & W

Saves Monmouth Memorial Hospital $10,000 a Year

"Package" Boiler Supplies Clean, Dry Steam for Many Uses

An oil-fired B&W Integral-Furnace Boiler is saving $10,000 a year for the 350-bed Monmouth Memorial Hospital at Long Branch, New Jersey. This boiler heats the hospital, nurses' residence, doctors' office building, and clinic. It supplies steam for the cafeteria, main kitchen, floor pantries, sterilizers, and laundry.

Cost of Fuel Consumed Each Year equals original cost of boilers in most cases. You'll be surprised how much money you're burning. This is the money that really matters—not the initial cost of the boiler.

It Will Pay You to look at your steam costs regardless of your demands, whether large or small, or for process or heating. During the normal life expectancy of many boilers, the fuel bill can amount to several million dollars. Unless it is well engineered, serviced, and maintained, a boiler's efficiency can drop off 2 or 3 per cent or even more. This amounts to a substantial sum of money.

You Save on Your Steam Supply with a B&W Boiler. It pays to buy the best —top level engineering, long range sustained economy, and best performance. A national network of plants and engineers, supported by nearly a century of steam generating experience, is yours with B&W.

The Babcock & Wilcox Company, Boiler Division, 161 East 42nd Street, New York 17, N. Y. G-840-1B

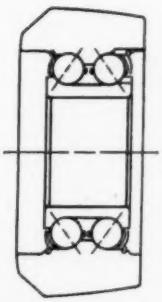
BABCOCK & WILCOX

BOILER DIVISION

MODERN STEAM MAKES YOUR PRODUCT BETTER AT LOWER COST

ND FACTS

HYSTER CHOOSES NEW DEPARTURE BALL BEARINGS FOR RUGGED DUTY!

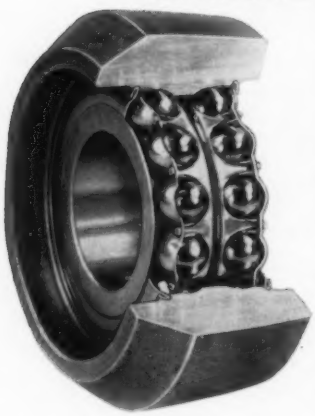


Extra-wide outer ring with special hardened ground "tire" provides more contact area to reduce mast brinelling.

PHOTO: COURTESY OF HYSTER COMPANY

Lift truck equipped with New Departure Double-Row Mast Guide Bearings

Despite twist and sway caused by off-center loads on lift trucks, New Departure mast guide bearings permit lifting operations without undue wear. More important, wear caused by sliding metal-to-metal contact between channel members is eliminated.



Width of double-row angular-contact bearing is less than that of two single-row angular-contact bearings. Permanent preload is built in at assembly.

These new double-row guide bearings take *radial* and *thrust* loads from all directions. The very heavy-section outer ring gives added shock resistance required for rugged duty. The extra width of the outer ring provides more contact to reduce mast brinelling.

These bearings give the same advantages common to all New Departure ball bearings—unexcelled long-life performance in handling heavy combined loads . . . lowest operating friction for consequent improvement in horsepower efficiency. Also, there is no need for relubrication or adjustment throughout years of service.

For additional information, contact your New Departure Sales Engineer or write for data sheet MGB-2.

1908–1958 GM FORWARD FROM FIFTY

ND NEW DEPARTURE

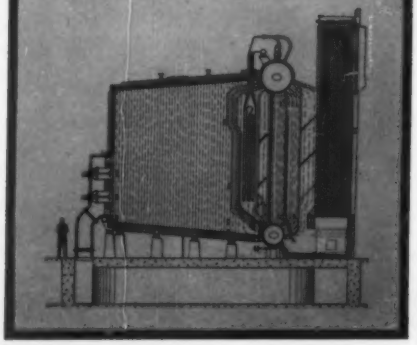
DIVISION OF GENERAL MOTORS, BRISTOL, CONN.

NOTHING ROLLS LIKE A BALL

C-E Boilers exceed guarantees at ANHEUSER-BUSCH, Inc.

The Newark, N. J., brewery of Anheuser-Busch, Inc. The seven year old power plant, left, is so spectacularly clean and neat that it has constituted a major attraction for professional and technical groups along the eastern seaboard. The popularity of these tours is such that, currently, reservations must be made two months in advance.

(Above) One of the two C-E Type VU-50-B, oil-fired boilers in the Newark brewery (cross-section below). Each has a maximum continuous capacity of 100,000 lb per hr and produces steam at 550 psi and 750 F. The floor in the foreground is chemically cleaned daily, polished twice weekly and completely refinished yearly.



In a brewery, the demands placed upon its boilers can be rigorous indeed. At the Anheuser-Busch brewery in Newark, New Jersey, they provide steam for power generation, for processing and for numerous high-capacity instantaneous water heaters used in various brewing and bottling operations. Since brewing is essentially a "batch" process, steam demands fluctuate sharply and continuously. Yet the C-E Boilers installed at Newark have consistently exceeded performance guarantees and operate at an efficiency of 86%.

Mr. Herman Paradies, Superintendent of Utilities at the Newark brewery, has stated that it is not unusual for steam demands to rise from 80,000 to 130,000 pounds per hour in ten to fifteen seconds, and that the boilers have responded with nominal loss in pressure or temperature. This enviable record, which speaks well both for boiler design and for the skills of the power plant's operating management and staff, is one of which Combustion is proud.

When *you* need boilers, remember that C-E has a complete line of time-tested and service-proved designs and that there is a size and type which will fit your needs and serve you equally well.

COMBUSTION ENGINEERING

Combustion Engineering Building
200 Madison Avenue, New York 16, N. Y.

C-E

C-164A

ALL TYPES OF STEAM GENERATING, FUEL BURNING AND RELATED EQUIPMENT; NUCLEAR REACTORS; PAPER MILL EQUIPMENT; PULVERIZERS; FLASH DRYING SYSTEMS; PRESSURE VESSELS; SOIL PIPE

MECHANICAL ENGINEERING

PUBLISHED BY
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THE COVER

Mach twenty-eight is correct. That's the equivalent air speed now developed in General Electric's helium wind tunnel at Schenectady. The shock-wave pattern shown is formed by the helium flow around a ½-in. hemispherical model supported in the tunnel by a heavy sting. Helium is stable at high speeds, whereas air breaks down into elements, compounds, and ionized particles. Why such velocities? It took Mach 25 to put Explorer I into orbit. Needed to escape the earth's gravitational field: Mach 35.

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"B&W Tubing

assures easy fabrication–top quality operation

for our hydraulic cylinders

As a hydraulic engineer, I'm interested in getting components that cut my fabrication work to a minimum without loss of end-use quality. That's why I always specify B&W Seamless Mechanical Tubing. It's *consistently* of the highest quality . . . and needs very little reworking."

This particular case history, documented in B&W's files, is only one example of the many successful applications of B&W Mechanical Tubing. Because of the high-precision standards to which it is produced, B&W Mechanical Tubing is received from the mill in a condition that often represents 90% of the unit for which it is intended. Advantages to engineers and craftsmen include high strength-to-weight ratio, as well as ability to assume almost any design shape without loss of structural advantages, material, weight and space savings.

B&W Mechanical Tubing is produced to order, to special sizes, shapes, finishes and analyses and to the mechanical properties needed in the end-use application. Ask for Mr. Tubes, the B&W specialist—he can help you simplify tube fabrication problems—or write for Bulletin TB-361. The Babcock & Wilcox Company, Tubular Products Division, Beaver Falls, Pa.

B&W TUBULAR PRODUCTS DIVISION

TA–8010–M–3

Seamless and welded tubular products, solid extrusions, seamless welding fittings and forged steel flanges—in carbon, alloy and stainless steels and special metals.

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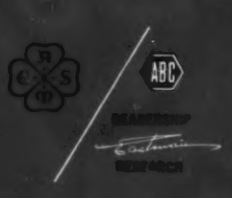

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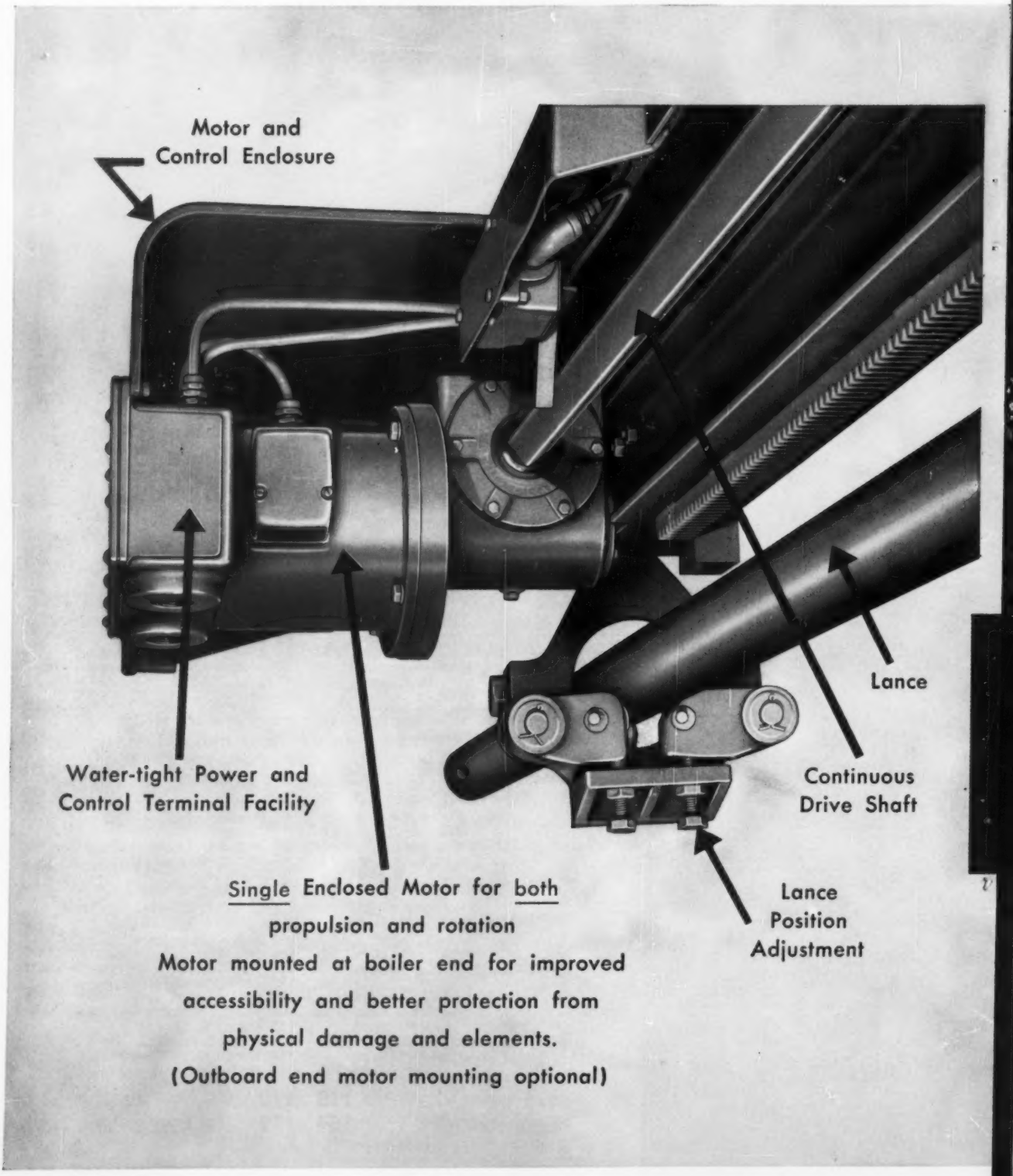

Single Enclosed Motor for both
propulsion and rotation
Motor mounted at boiler end for improved
accessibility and better protection from
physical damage and elements.
(Outboard end motor mounting optional)

Single-Motor DRIVE

another important feature of

New Du

Series 300 IK
LONG RETRACTING BLOWER

As illustrated at the left, only *one motor* is used to simultaneously propel and rotate the lance tube of the new Series 300 IK. The motor is stationary and is mounted at the boiler wall for easier accessibility and greater protection from physical damage and the elements (note the protective enclosure). This front end single-motor drive is simple and dependable. There is only *one* set of motor elements . . . *one* set of control elements . . . and *one* set of power supply facilities to operate and maintain.

Additional important features of the new Series 300 IK are listed in the panel below. Check them and you will understand why this blower is establishing a new standard of efficiency, economy and dependability in cleaning those heating surfaces that require a long retracting blower. For further information about the new Series 300 IK, ask your local Diamond office or write directly to Lancaster for Bulletin 2111 AA.

OTHER ADVANTAGES OF SERIES 300 IK BLOWERS

- Backbone and Protective Cover
- Compact, Accessible Electric Power and Control Terminal Facilities
- Nozzle-Sweep-Every-Inch Cleaning Pattern
- Improved "Type A" Nozzle
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- Poppet Valve with Adjustable Pressure Control
- Positive Mechanically Operated Valve
- Single Point Outboard Suspension
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- Auxiliary Carriages for Extra Long Travel
- Designed for Quick, Easy Servicing

No other blower gives you all these advantages.

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DIAMOND POWER SPECIALTY CORPORATION

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You, too—

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• In a field where continuous and economical operation is a prerequisite for success, dependability in steam generating equipment is mandatory.

Erie City Iron Works has hundreds of installations in the *petrochemical* field operating under all types of conditions. Dependence on Erie City products did not just happen . . . it was earned. Erie City engineers work closely with *petrochemical* engineers to produce a custom designed boiler or to adapt a standard unit to suit the particular requirements. Erie City's broad and most complete line of steam generating equipment is available for large central steam producing stations or portable steam producing units located in remote areas of the plant. When waste gases were available, Erie City's Fire Tube or Water Tube Waste Heat Boilers have turned these gases into economical steam.

When we say *"you can depend on Erie City for sound engineering,"* we point with pride to the leaders we serve.

Write for general catalog SB 508-4G

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STEAM GENERATORS • SUPERHEATERS • ECONOMIZERS • AIR PREHEATERS • WASTE HEAT BOILERS
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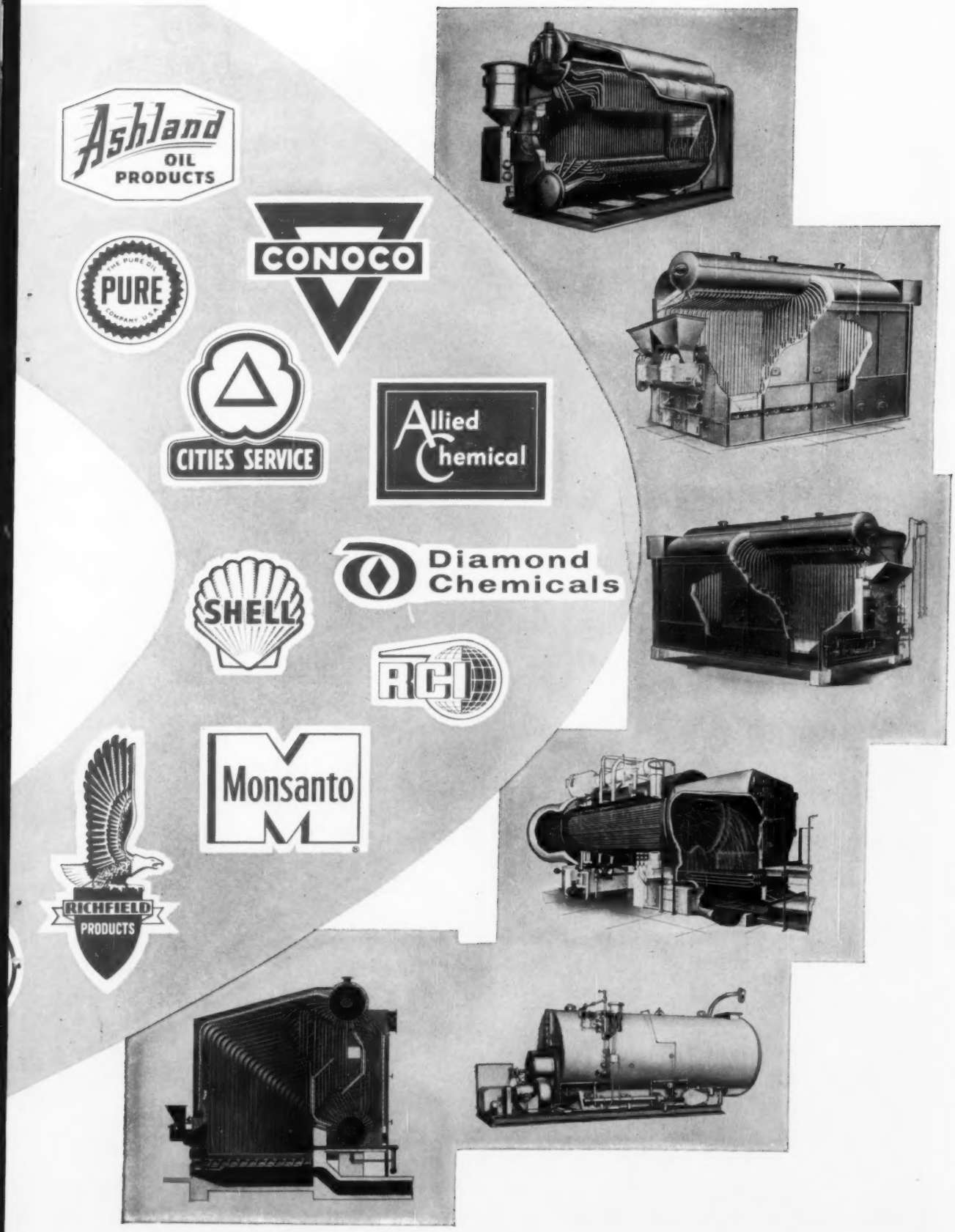
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B. F. Goodrich

rides with coal

Tire manufacturer enlarges steam facilities; continues coal for economy, reliability

At its Oaks, Pa. plant, The B. F. Goodrich Co. uses steam principally for curing tires. When increased demand for its tires created the need for plant expansion in 1954, B. F. Goodrich found its original boiler plant could not supply sufficient steam. Completely new equipment was installed to increase capacity. But B. F. Goodrich continued to burn the economical fuel it had used in the past—coal.

In this modern coal-burning steam generation system, coal handling, ash disposal and the entire furnace operation are automatic. As a result of this modernization, fuel costs and manpower needs have been held to a minimum. And, in four years of operation, this installation has required only routine maintenance and repairs.

Facts you should know about coal

You'll find that bituminous coal is not only the lowest-cost fuel in most industrial areas but up-to-date coal burning equipment can give you 15% to 50% more steam per dollar. Today's automatic equipment can pare labor costs and eliminate smoke problems. And vast coal reserves plus mechanized production methods mean a constantly plentiful supply of coal at stable prices.

Technical advisory service

To help you with industrial fuel problems, the Bituminous Coal Institute offers a free technical advisory service. We welcome the opportunity to work with you, your consulting engineers and architects. If you are concerned with steam costs, write to the address below. Or send for our case history booklet, complete with data sheets. You'll find it informative.

Consult an engineering firm

If you are remodeling or building new heating or power facilities, it will pay you to consult a qualified engineering firm. Such concerns—familiar with the latest in fuel costs and equipment—can effect great savings for you in efficiency and fuel economy over the years.

BITUMINOUS COAL INSTITUTE

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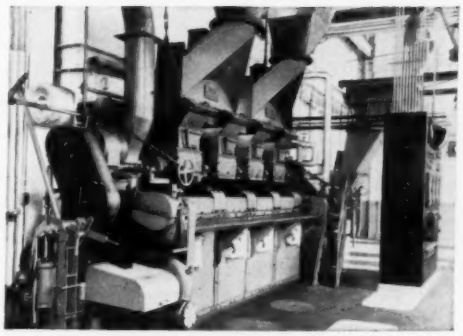
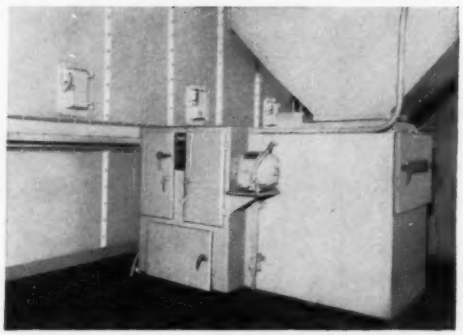


View of 100,000 lb/hr Wickes Boiler at B. F. Goodrich, fired by Detroit Rotograte Stokers. Coal is gravity fed from overhead bins through weighing equipment into stoker hoppers. Conveyor system is by Stock Equipment Co.



Shown here are overhead feeder and Stock coal-weighing equipment. This operation is all automatic. Coal goes from here to stoker.

Close-up of Stock coal elevator, conveyors and swinging spout used to stock out coal. Ash silo is part of United Conveyor ash handling system.

Coal storage area, showing level, compacted coal pile. Coal is stocked out from swinging spout by bulldozer, which later reclaims it to the track hopper for conveying into power plant.

THE WORLD'S FIRST CARD-OPERATED MILL,

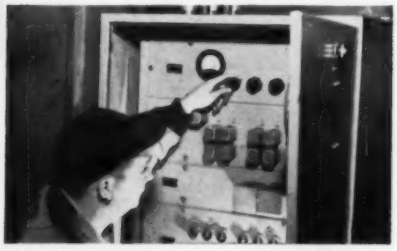
PROMISES YOU BETTER STEEL—AUTOMATICALLY

HIGHER QUALITY

MORE
UNIFORM SIZE

BETTER
PHYSICAL PROPERTIES

New method provides a large file of schedules for various types of steel.



General Electric engineers, working closely with AL personnel, developed and installed the control systems which regulate the mill.

Better quality, more uniform steel is the result.

A NEW punch-card control system, recently installed on the 56″ universal roughing mill at Allegheny Ludlum's Brackenridge, Pa. plant, is advancing mill standards of quality control.

Here's how it works: Allegheny Ludlum rolling experts predetermine optimum rolling procedures for the type of steel desired and translate this data into punches on an IBM card. These punches represent the proper screwdown settings, mill speed and number of passes. When the mill schedule calls for it, the mill operator in the pulpit simply selects the proper card, inserts it into the card reader, and he is ready to roll. As the operator makes each pass, the mill is automatically adjusted for each additional pass required. The rolled material is held uniformly to desired dimensions, and day in, day out it proves to have better, more constant physical properties.

It's easy to see how this kind of progress fits into your interest in consistent high quality. By performing rolling operations exactly the same way time after time, this new unit further assures Allegheny Ludlum customers that they are getting the best possible product from the industry's pioneer producer.

Let us talk over your requirements with you. Write us, or call the Allegheny Ludlum sales office nearest you, and an AL sales engineer will help you with any problem. ***Allegheny Ludlum Steel Corporation, Oliver Building, Pittsburgh 22, Pennsylvania.***

WSW 6426

PIONEERING on the Horizons of Steel

Allegheny Ludlum

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IN SRE... Zallea expansion joints absorb thermal expansion of reactor core tank and outer tank

The very nature of the Sodium Reactor Experiment, conducted by Atomics International for the AEC, and the method of handling the liquid sodium reactor coolant demand reliability in expansion joints. Because of the operation there can be no compromise in design or quality.

The high temperature SRE uses Zallea Expansion Joints where thermal expansion must be absorbed and where a gas seal must be maintained. An 11-ft. diameter Zallea Expansion Joint at the top of the outer tank absorbs the expansion that results from the temperature increase in these components as the reactor comes up to operating temperature, 960°F. In addition, the expansion joints form a seal for the helium gas and sodium vapor above the sodium pool at the top of the reactor as well as for the helium gas within the outer tank.

In the sodium coolant piping circuit gas seals are effected by means of Zallea Expansion Joints in the region where the pipes leave the reactor cavity and enter the pipe galleries.

Zallea has worked with almost every major engineering and manufacturing firm engaged in atomic, nuclear and missile work—and has provided the large majority of expansion joints for such projects. As a result, we have accumulated a store of expansion joint engineering data and manufacturing skills that cannot be equalled. Whenever expansion is involved in piping systems, reactors, tanks—whatever the application—let our engineers work with you. We already have the answer to many of the difficulties you will encounter. And we welcome the chance of tackling your problem.

Zallea
expansion joints

ZALLEA BROTHERS, Wilmington 99, Del. • World's largest manufacturer of expansion joints

ANOTHER REPUBLIC ENGINEERING ACHIEVEMENT!

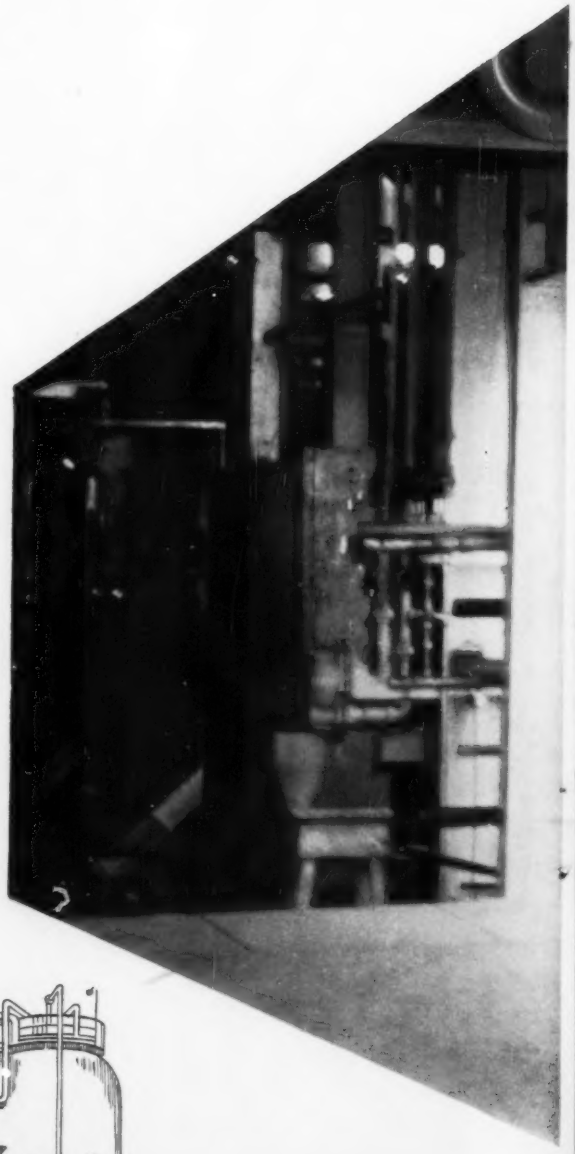
Republic Controls Maintain Efficient Production of 5,000,000 Gallons of 330F Water Per Day

. . . at Pan American Sulphur Company, Jáltipan, Veracruz, México

At Pan American's Jáltipan plant, six 100,000 lbs/hr fuel oil fired boilers generate the steam required to heat the hot water needed to produce in excess of 1,000,000 tons annually of Frasch sulphur. Each boiler, furnished with F.D. and I.D. fans and steam atomizing oil burners, is controlled by a Republic pneumatic combustion control system. Feedwater to individual boilers is controlled by a Republic single-element system, consisting of drum-level transmitter, controller, manual-automatic station and valve.

Republic's performance on this job has been outstanding. The control system has functioned without difficulty, day in and day out, since installation in 1954. This record stands, despite exposure to the damp, torrid climate of southern Mexico, where 100% relative humidity and 130F temperatures are common. Personnel recruited from the immediate area were trained on the job, and have operated the plant since its completion.

Republic's experience with plants of all sizes, all pressure and temperature ratings, and all load characteristics is your best guarantee of getting all the premium performance built into your major equipment. A technically-trained, thoroughly experienced Republic Engineer is ready to discuss your instrument and control problems. Republic sales offices are located in principal cities throughout the United States and Canada.

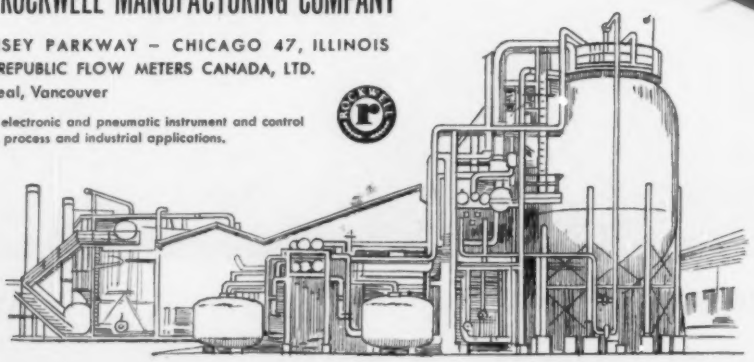


REPUBLIC
FLOW METERS CO.

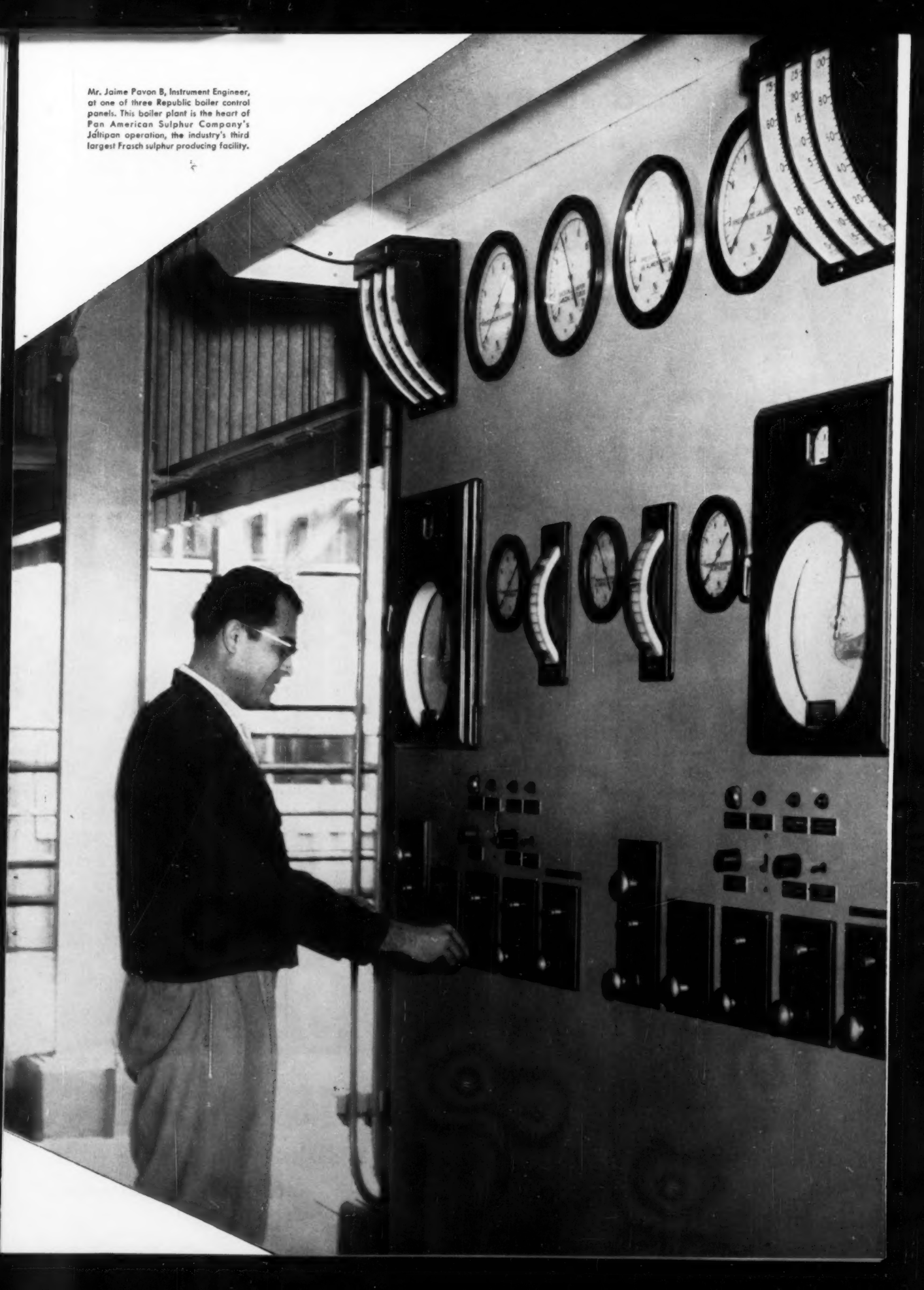
Subsidiary of ROCKWELL MANUFACTURING COMPANY

2240 DIVERSEY PARKWAY – CHICAGO 47, ILLINOIS
IN CANADA: REPUBLIC FLOW METERS CANADA, LTD.
Toronto, Montreal, Vancouver

Manufacturers of electronic and pneumatic instrument and control systems for utility, process and industrial applications.



PAN AMERICAN SULPHUR CO.
President: Mr. Harry C. Webb
Design engineering & construction: Brown & Root, Inc.
Instruments, combustion and feedwater controls: Republic Flow Meters Company, Chicago



Mr. Jaime Pavon B, Instrument Engineer, at one of three Republic boiler control panels. This boiler plant is the heart of Pan American Sulphur Company's Jáltipan operation, the industry's third largest Frasch sulphur producing facility.

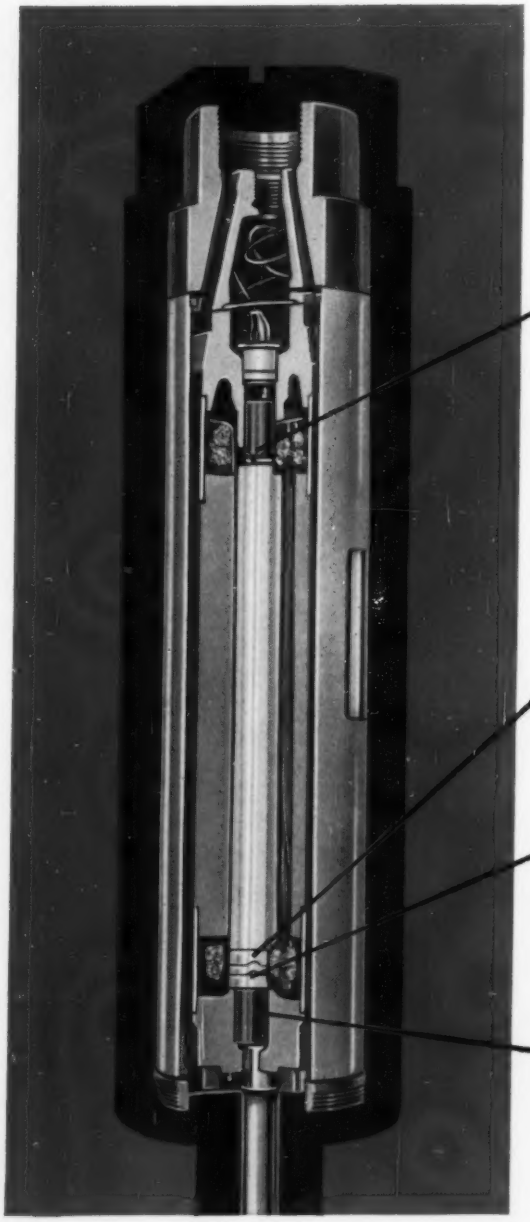
In Leland submersible pump motors

GRAPHITAR® (CARBON-GRAPHITE) and GRAMIX® (PRODUCTS OF POWDER METALLURGY)

operate with gasoline

as the only

lubricant!



Running directly in gasoline, this superbly-designed Leland submersible motor embodies two GRAMIX thrust washers and two GRAPHITAR bearings to keep the operation of this amazing explosion-proof pump motor safe and smooth.

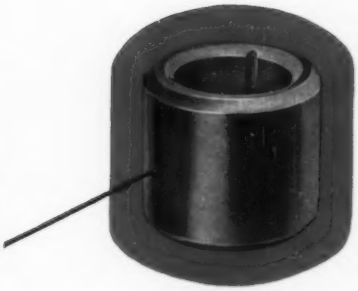
Thirty years ago the manufacturer of these pumps—the Leland Electric Co., Dayton, Ohio, a division of American Machine and Foundry Co., developed the first gasoline curb-pump motor to receive Underwriters' Laboratories' approval. Throughout their long experience, they have selected every component with great care. It is thus significant that for Leland's submersible motor they selected GRAPHITAR and GRAMIX bearings.

GRAPHITAR is a non-metallic, carbon-graphite material that will not weld or score even when in contact with a metal shaft. Any liquid will act as a lubricant, thereby reducing friction and increasing service life. With low-viscosity liquids such as gasoline, friction is at a minimum because of the low film strength.

GRAMIX, tough, long-wearing sintered-metal, has an extremely high particle hardness and excellent surface finish; can be precision die-pressed to tolerances within .0005". GRAMIX parts can withstand incredible amounts of pounding action. These factors, coupled with their extremely low cost, have helped add to the increasing use of GRAMIX parts in many industries.

THE UNITED STATES

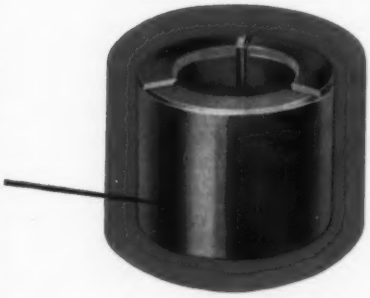
GRAPHITAR® CARBON-GRAPHITE • GRAMIX® POWDERED METAL PARTS • MEXICAN® GRAPHITE PRODUCTS • USG® BRUSHES



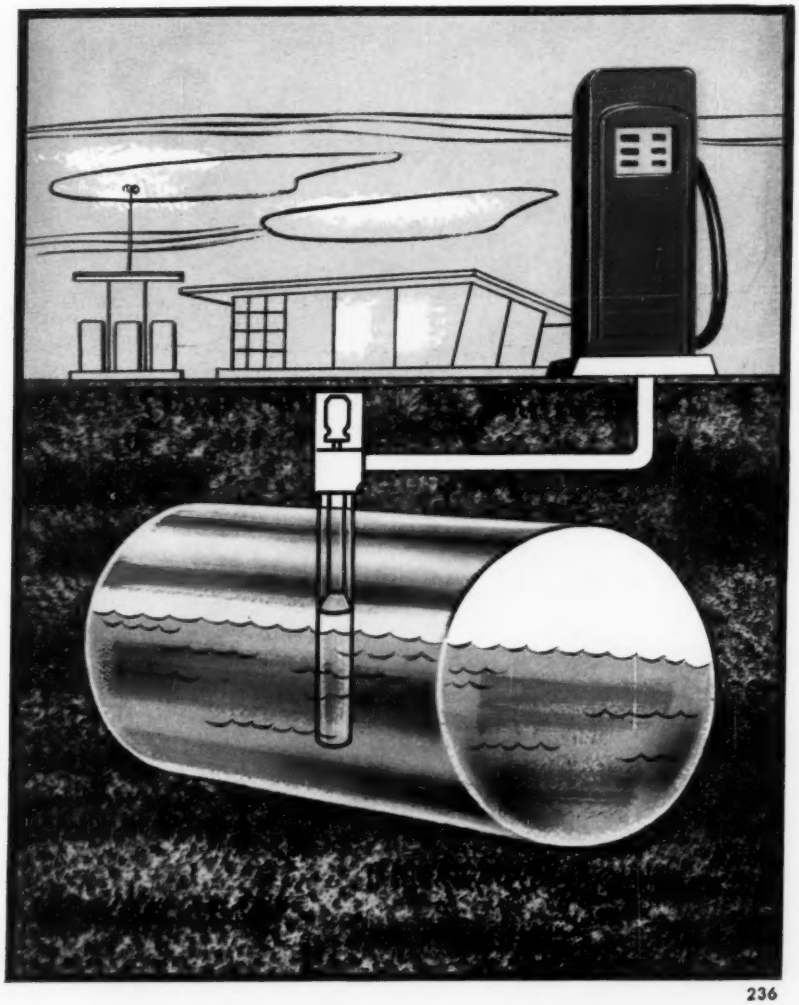
GRAPHITAR
GRADE 14
RADIAL BEARING

GRAMIX STEEL
THRUST BEARING
DRIVE

GRAMIX HARDENED
STEEL THRUST PLATE



GRAPHITAR RADIAL
AND THRUST BEARING



236

Write today for these two new engineering bulletins, GRAPHITAR Bulletin No. 20 and GRAMIX Bulletin No. 21.

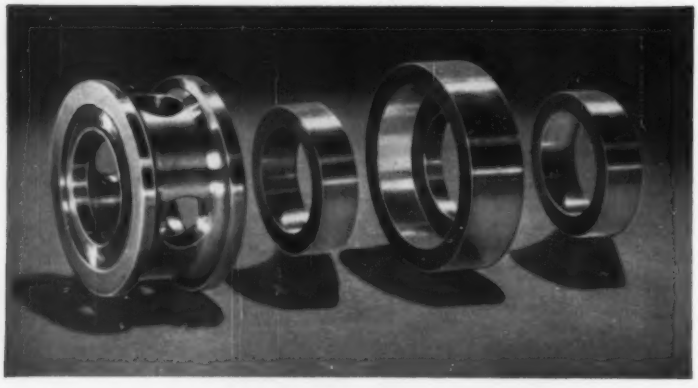
GRAPHITE COMPANY

DIVISION OF THE WICKES CORPORATION, SAGINAW 4, MICHIGAN

SINGLE BUSHING TYPE Floating Ring Seal

Seal Any Medium—Even Corrosive Media ...with Koppers Floating Ring Seal

MULTIPLE RING TYPE Floating Ring Seal (assembled)



FLOATING RING SEAL Basic Elements: Lantern Ring, Floating Ring, and Spacer Diaphragm. As sealing needs dictate, floating rings and spacer diaphragms are added. Seals are carbon, plastics, ceramics or steel, as applications require.

The Only "No Maintenance" Seal for Rotating, Oscillating and Reciprocating Motion

Koppers' precise, efficient Floating Ring Seal assures long seal life, low leakage, reduced wear, less power consumption, and decreased operating costs.

It seals at high temperatures and at pressures up to, and for some conditions even above, 2000 psi. Inspection has shown that after 10,000 hours of operation, ring and spindle wear can be negligible. For water at 500° F. and 1200 psig with a $\frac{5}{8}$" spindle, leakage is only one to two pounds per hour. Frictional power requirements are virtually zero, and Koppers' design reduces radial frictional restraint. Sealing members adapt to changes in the shaft's position.

Applicable to valve spindles, pumps, atomic reactor spindles and many other similar installations, Koppers Floating Ring Seal gives efficient, low-cost service for the sealing of all types of fluids under widely varying conditions of temperature and pressure.

For additional information, write to: KOPPERS COMPANY, INC., Piston Ring and Seal Department, 9307 Hamburg Street, Baltimore 3, Maryland.

KOPPERS

MECHANICAL SHAFT SEALS

Engineered Products sold with *Service*

Nature at her best is beyond improving...

Imported Castell lays down the blackest BLACKS

because it is saturated with **"black gold"** graphite of more than 99% pure carbon.

Nature at her best produces "black gold" graphite for imported CASTELL. Because this natural graphite assays at more than 99% pure carbon, there is no need to add foreign sustances. CASTELL is *born* black.

Our job is to refine this superior graphite through our exclusive microlet-milling process—to reduce the granules to perfect cohesion and to encase the lead in the finest-grained cedar wood.

Thus, when you pick up a CASTELL in any of its 20 scientifically-uniform degrees, ranging from 8B to 10H, you are assured of clean, crisp, extremely opaque lines that will not flake or feather even after hundreds of trips through the blueprint machine. There's no need to constantly brush away graphite dust. CASTELL graphite is close-textured and non-crumbling, reducing stains and smudges to a minimum.

You owe it to your career to use CASTELL, the Drawing Pencil of the Masters. All good dealers carry famous CASTELL. Why not call *yours* today.

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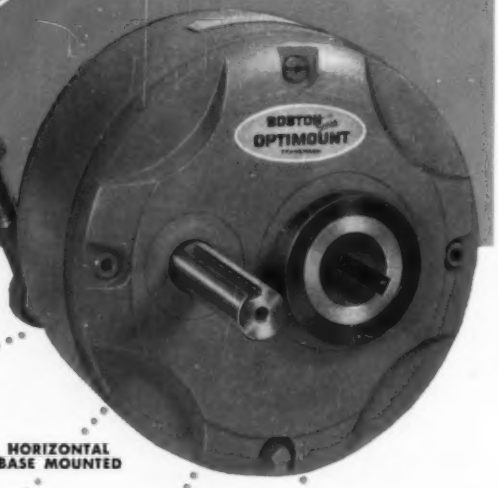
PREFERRED BY PROFESSIONALS IN EVERY CIVILIZED COUNTRY ON EARTH.

OPTIONAL MOUNTING
OPTIMUM PERFORMANCE

BOSTON Gear
OPTIMOUNT
TRADEMARK

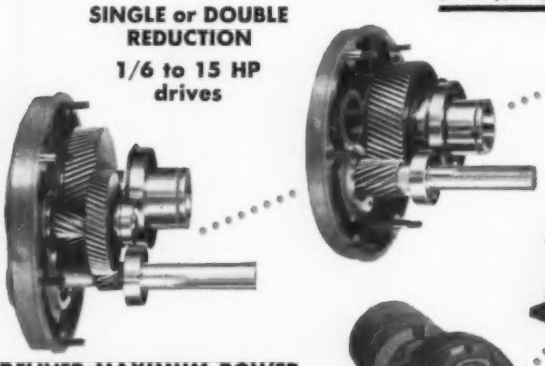
HELICAL GEARED
REDUCTORS • RATIOMOTORS
AND FLANGED REDUCTORS
SHAFT MOUNTED and BASE MOUNTED

A New achievement in STANDARDIZATION by industry's most experienced specialists in speed reducer design

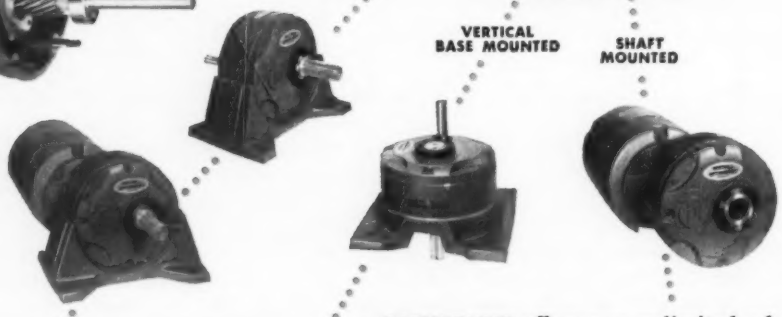


From Stock

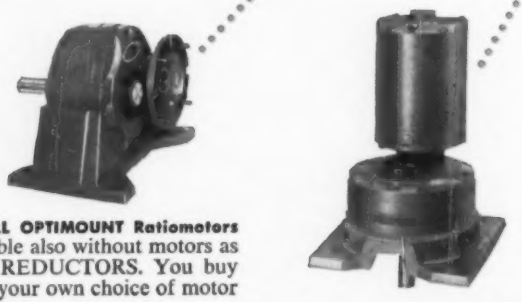
SINGLE or DOUBLE REDUCTION
1/6 to 15 HP drives



HORIZONTAL BASE MOUNTED
VERTICAL BASE MOUNTED
SHAFT MOUNTED



DELIVER MAXIMUM POWER with highest efficiency. Precision helical gearing made by BOSTON Gear specialists, — in units tested and proved to meet the highest quality standards.



ALL OPTIMOUNT Ratiomotors are available also without motors as FLANGED REDUCTORS. You buy and attach your own choice of motor

OPTIMOUNT offers you unlimited adaptability to modern drive demands, in helical geared speed reducers made to BOSTON Gear quality standards.

Call your Distributor for complete information. Let him demonstrate the design features that assure top-rated efficiency and lasting economy. Boston Gear Works, 66 Hayward St., Quincy 71, Mass.

66 MODELS FROM STOCK

680 OPTIONAL MOUNTING ARRANGEMENTS

For nearest Distributor LOOK UNDER "GEARS" in the 'Yellow Pages'

CALL YOUR BOSTON Gear DISTRIBUTOR

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NEW Catalog OP-1 lists complete data on OPTIMOUNT, — selection charts, engineering data. Get your copy from your local Distributor.

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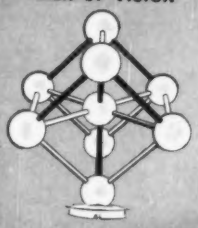

A 2-WEEK, ALL EXPENSES PAID TOUR FOR TWO

to the Brussels World's Fair

(VIA SABENA BELGIAN WORLD AIRLINES)

AWAITS THE WINNER OF THE "JOBS FOR TOMORROW" CONTEST

sponsored by MICROBEADS, Inc.

MANUFACTURERS OF MICROSCOPIC GLASS BEADS

7 OTHER VALUABLE PRIZES

2nd PRIZE—Admiral Portable Color Television Set

3rd through 8th PRIZE—Admiral Portable Air Conditioners

Each winner will also receive an award certificate.

YOUR IDEA

FOR A NEW USE OF MICROBEADS MAY BE A WINNER — SEND FOR CONTEST KIT TODAY!

MICROBEADS . . . A BASIC NEW MATERIAL WITH UNLIMITED POSSIBILITIES—Microbeads are manufactured in sizes ranging from 1 micron to over 1000 microns. The specific gravity range of Microbeads is from 2.4 to 4.6. Refractive index ranges from 1.51 to 1.93.

The primary market for Microbeads is in the field of reflectorization—signs, pavement markings, etc. They have gained wide usage in traffic control products and in the medium of outdoor advertising. We feel, however, that these uses are only the beginning . . . a small portion of the overall role Microbeads is destined to play throughout industry. This thinking is prompted by the many men of vision who have approached us with imaginative ideas for new uses of this product. Some are practical . . . some are not. However, an amazing percentage of these ideas have proven themselves to be both practical in use and feasible from a cost standpoint.

The material contained in the contest kit describes a number of these suggested new uses. Perhaps one of them will spark an idea within yourself . . . and you'll find yourself winging your way across the Atlantic . . . bound for an unforgettable two weeks at the FAIR.

Contest Kit contains samples of Microbeads, general information, fact sheet, official rules, official entry form . . . everything you need to help you win.

Those ideas win which, in the opinion of the judges, will create the most jobs in the next five year period and which most successfully combine originality, feasibility and practicality. The idea itself is all-important; not the depth of development. Serving on the panel of judges are: Dr. R. P. Dinsmore, Vice President Research and Development, Goodyear Tire and Rubber Co., Akron, Ohio; Dr. H. W. Welch, Jr., Director Research and Development, Military Electronics Division, Motorola, Inc., Phoenix, Arizona; Mr. John J. Hanlon, Technical Director, Mohasco Industries, Inc., Amsterdam, New York.

MAIL THIS COUPON TODAY!

CONTEST CLOSES AUGUST 15, 1958

Microbeads, Inc. – P. O. Box 241 – Jackson, Mississippi

Gentlemen:

Please send Official Entry Kit for your "JOBS FOR TOMORROW" CONTEST to:

Name .....

Title .....

Organization .....

Nature of Industry .....

Address .....

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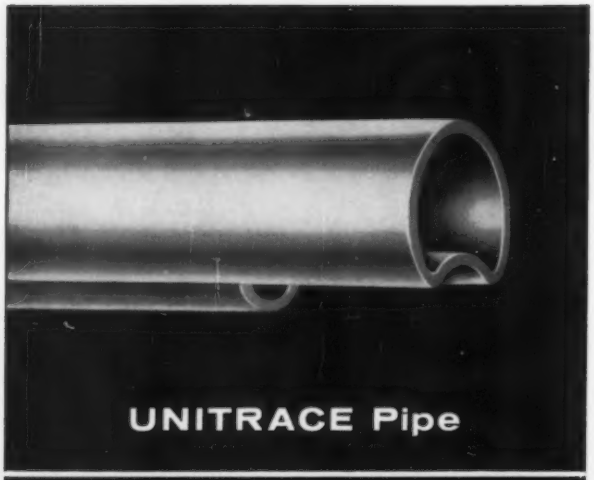
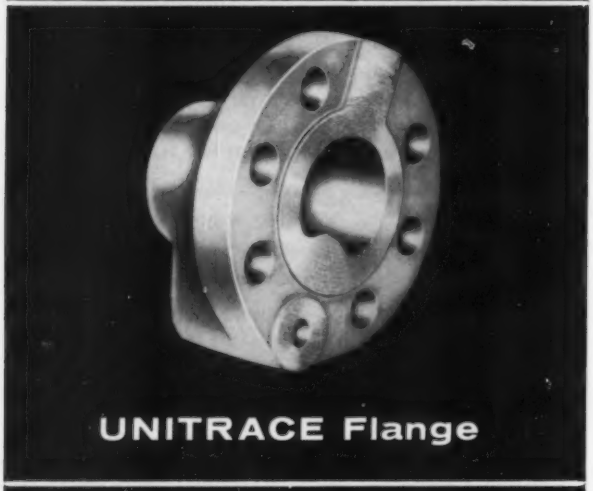
MICROBEADS, Inc.

P. O. BOX 241 / JACKSON, MISSISSIPPI

MICROSCOPIC GLASS BEADS FOR INDUSTRIAL AND REFLECTIVE PURPOSES



UNITRACE Pipe



UNITRACE Flange

UNITRACE Trace Cap

Only **ALCOA** offers a complete new **UNITRACE** system

to cut costs and raise efficiency of steam-traced piping

Users of steam-traced pipe have found that valuable savings in cost plus greatly improved efficiency are automatic when they use ALCOA® UNITRACE. It provides steam and product passages extruded in a single unit of light, strong, corrosion-resistant aluminum alloy... completely eliminating the need for costly external steam jackets or inefficient tracer tubes. Now a new flange and trace cap provide fittings and connections designed for UNITRACE which are compatible with conventional piping. You can now design completely integrated UNITRACE piping systems and get all these benefits:

Low heat loss ... high internal heat transfer
The recently introduced *round* configuration of UNITRACE makes possible most efficient internal heat transfer with minimum external radiation loss.

Easy, economical joints and connections
The special UNITRACE Flange mates with all 150-lb ASA flanged connections, permits use of standard flanged valves or other flanged connections. And the new UNITRACE Trace Cap permits quick, easy assembly of cross or tee connections.

Uses standard, preformed pipe insulation
The efficiency of UNITRACE often makes insulation unnecessary. When it *is* needed, standard preformed insulation can be used. UNITRACE saves extra dollars by employing smaller diameter insulation than conventional systems.

Excellent corrosion resistance
Thanks to the natural corrosion resistance of aluminum, UNITRACE is ideal for handling naval stores, molten sulfur, ammonium nitrate solutions, glacial acetic acid, fatty acids, tar, pitch, wax, urea, and similar products requiring heated transfer lines.

ALCOA UNITRACE and matching fittings are available in four standard pipe OD's: 1½", 2", 3" and 4". Get complete details on how you can use them to raise efficiency and lower cost on your own heated transfer lines. Call your nearest Alcoa sales office or write Aluminum Company of America, 894-G Alcoa Building, Pittsburgh 19, Pa.

Write for this FREE BOOKLET
This fully illustrated booklet contains complete engineering, specification and fabrication data on ALCOA UNITRACE. Write for your free copy!

ALCOA ALUMINUM
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"ALCOA THEATRE"
Exciting Adventure
ALTERNATE MONDAY EVENINGS

Vogt STEAM GENERATORS

at SUNTIDE REFINING COMPANY

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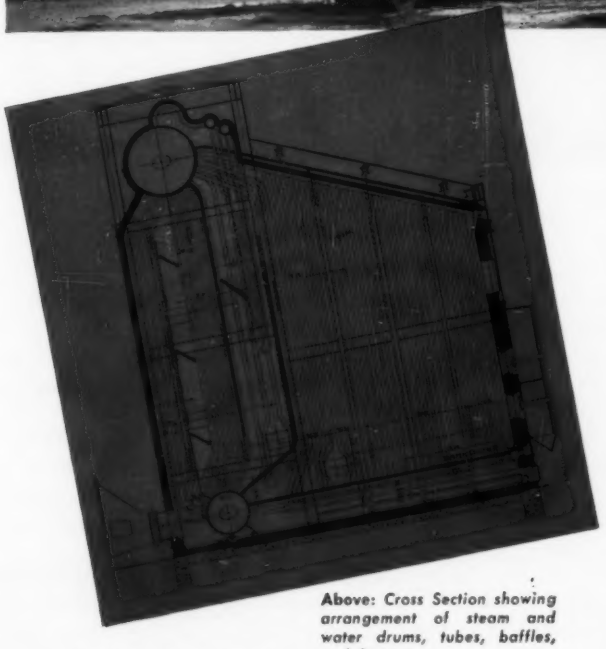


Above: Cross Section showing arrangement of steam and water drums, tubes, baffles, and furnace.

EFFICIENCY AND ECONOMY PROVED BY FIRST 3 UNITS . . .

2 MORE ADDED!

Principle Data Each Unit

- 85,000 pounds steam per hour capacity, designed for 500 lbs. S.W.P. and 625° F. total temperature.
- Water cooled furnace.
- Burners for Gas and Oil fuel.

Vogt offers a complete line of custom built and package type steam generators. Available in bent tube and straight tube designs for solid, liquid, or gaseous fuels burned singly or in combination.

Write for bulletins. Dept. 24A-BM

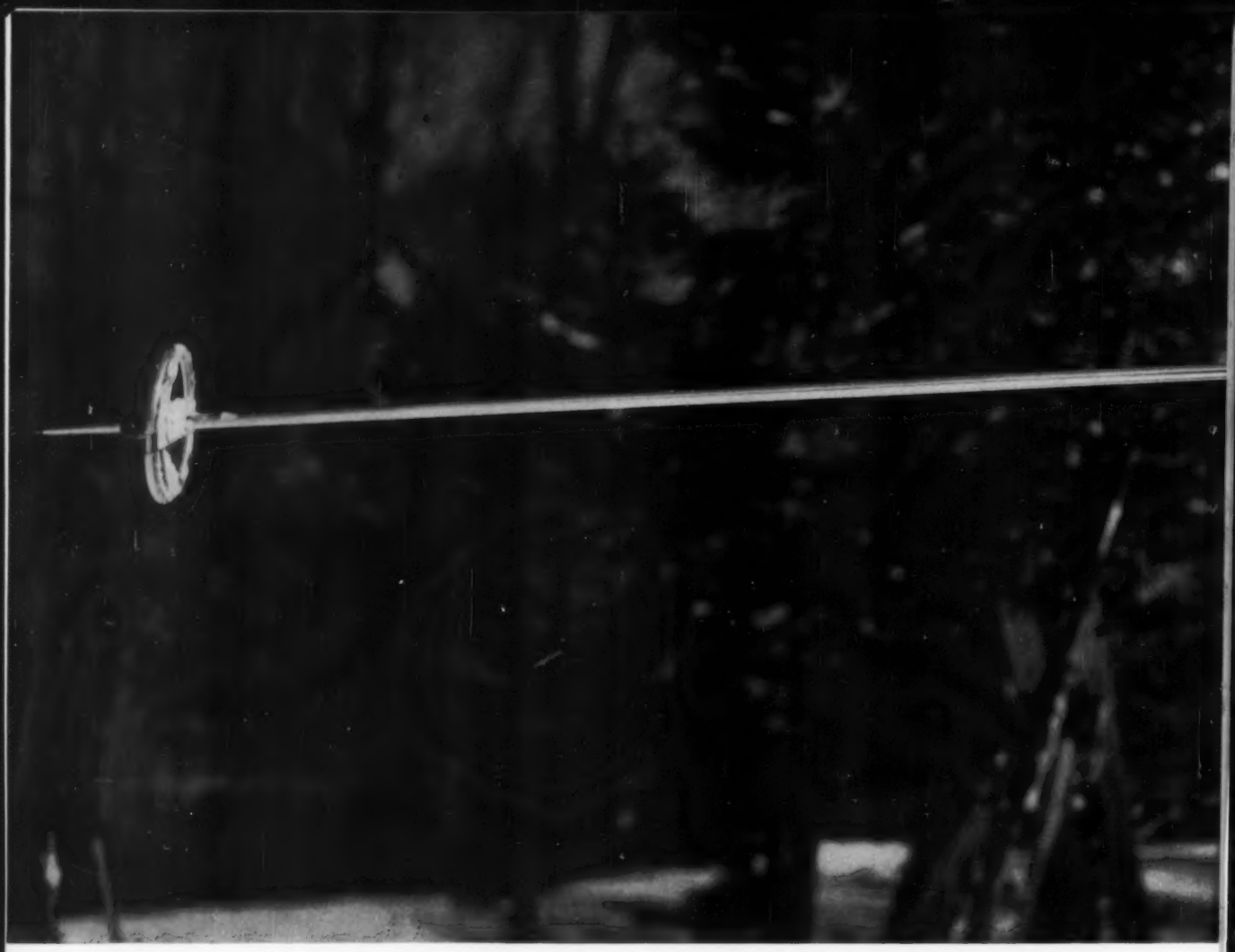
OTHER VOGT PRODUCTS

Drop Forged Steel Valves, Fittings and Flanges—
Petroleum Refinery and Chemical Plant Equipment
Heat Exchangers
Ice Making and Refrigerating Equipment

HENRY VOGT MACHINE CO.

Box 1918, Louisville 1, Kentucky

SALES OFFICES: New York, Chicago, Cleveland, Dallas, Philadelphia, St. Louis, Charleston, W. Va., Cincinnati



Lightness—There are a few products in this world that you don't want to be light—like pile drivers, dumbbells and paper weights. But generally speaking, every designer strives for the lightest product that will do the job, especially in things like truck trailers and off-highway earthmoving equipment (the lighter the unit, the greater the load capacity) and in structures like a bridge, which has to support itself *and* a roadbed.

Lightness is easy to attain. For instance, you could make a ski pole out of balsa wood, rather than the Stainless shown above, and never know you were holding it. But almost always as we strive for lightness, we also demand a certain amount of stiffness, ductility, strength. More than that, we need a material that can be fabricated on high-speed machinery.

So it's interesting to note that today, in cases where lightness is absolutely vital and *hang the cost*, designers still turn to steel rather than costlier materials when they need low weight and high performance.

When our Explorer I satellite screamed into outer space, it was cased in Stainless Steel. On every high-performance aircraft, the landing gear is made from ultra-strong steel because each single pound shaved from the landing gear assembly saves from 7 to 10 pounds of total aircraft weight, since it reduces the wing area, thrust and fuel required for the specified performance. Today, as we prepare for the first exospheric manned flight, we are completely sheathing the fuselage in steel, because no other available material has a better combination of lightness and high temperature strength.

In new, light-weight bridges, designers automatically think in terms of the new alloy and high strength steels. They're so strong that thinner, lighter sections can be used, and they have the extra atmospheric corrosion resistance necessary.

The new steels should be chosen and fabricated with care, and the final selection should be made by a skilled metallurgist—either on your staff or ours. United States Steel, 525 William Penn Place, Pittsburgh 30, Pennsylvania.

United States Steel Corporation • American Steel & Wire • Columbia-Geneva Steel • National Tube
Tennessee Coal & Iron • United States Steel Supply • United States Steel Export Company

USS United States Steel

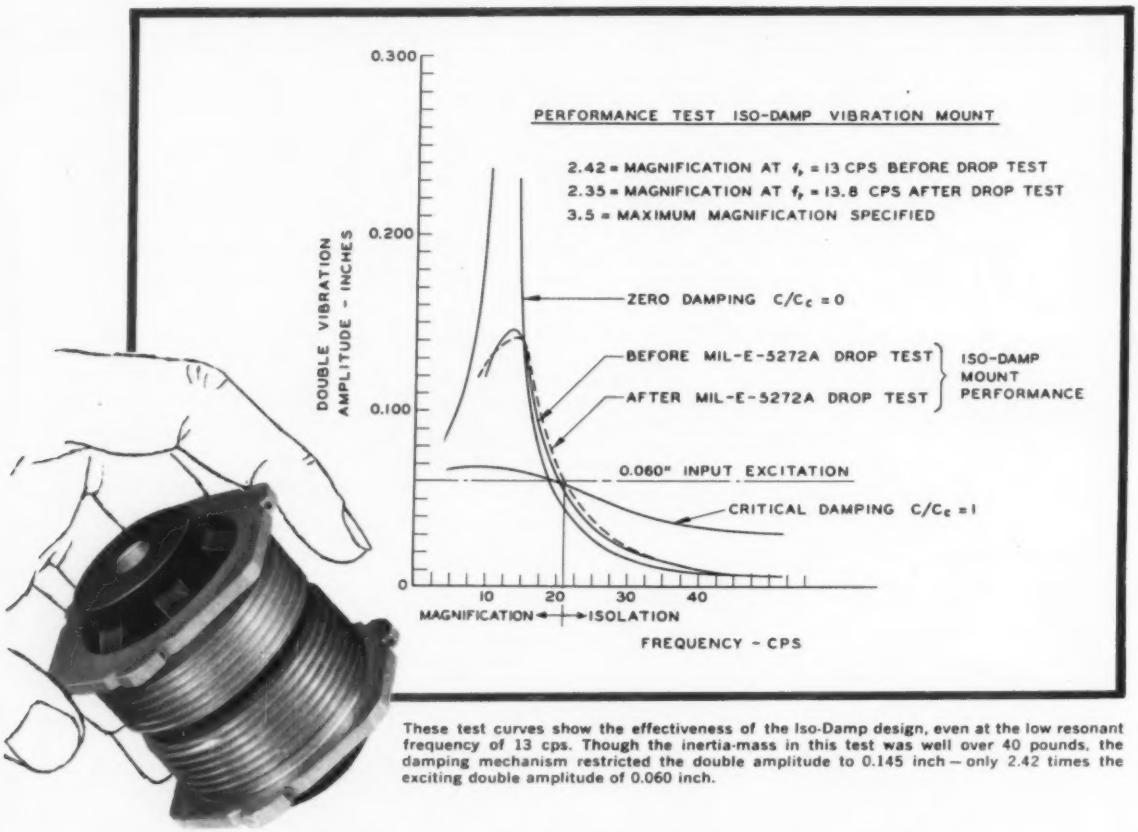
STEELS FOR DESIGN

Lower Left—Problem: Design a trailer to haul more coal and stay within the legal highway weight limit. Solution: Marion Metal Products Company used USS COR-TEN High-Strength Low-Alloy Steel to build a bigger trailer that is lighter because the stronger steel can be used in thinner sections. Payoff: The new units weigh 23% less than the old, have a 50% greater payload, and gross weight is *still* within the legal limit.

Lower Middle—Problem: Build a 40-ton-capacity bottom dump trailer that would have the highest payload-to-weight ratio ever obtained. Solution: Athey Products Corporation designed the unit with USS "T-1" Constructional Alloy Steel which combines a minimum yield strength of 100,000 psi with weldability and remarkable toughness. Payoff: New trailer weighs 11,000 pounds less than conventional construction and hauls payload over 3½ times its own weight.

Lower Right—Problem: Replace 550-bbl. fermentation tanks with new tanks of same capacity but light enough to hang from the ceiling. Solution: Chicago Steel Tank chose Type 304 Stainless Steel and a unique new design utilizing Stainless Steel's strength and formability. Payoff: New tanks weigh only one-fourth as much as the old and have identical capacity.

USS, COR-TEN and "T-1" are registered trademarks



These test curves show the effectiveness of the Iso-Damp design, even at the low resonant frequency of 13 cps. Though the inertia-mass in this test was well over 40 pounds, the damping mechanism restricted the double amplitude to 0.145 inch — only 2.42 times the exciting double amplitude of 0.060 inch.

MB Iso-Damp™ mounts give full frequency vibration control

A MOUNT soft enough to isolate vibration in the upper range of operating frequencies generally gives trouble when there's a low natural frequency present. It causes resonant build-up... magnifies the motion, as shown by the curve above. Not so the MB Iso-Damp mount. It works at *both* ends of the frequency spectrum... and in any position.

Resilient rubber sections with equal spring rates in all directions (an original MB mount principle) give high frequency isolation efficiency in any position. In the low range, resonance is restricted by a unique damping mechanism to well below a 3½ to 1 build-up. The mechanism does not affect high frequency isolation.

Iso-Damp mounts can be modified to special equipment requirements. They're available in a number of sizes, in threaded or press-in types. When assembled, the damping mechanism is totally enclosed and protected. Load capacities range from 15 to 100 pounds per mount.

MB concentrates on standard mounts which are actually in the *special performance* class. If you have a problem, lean on our 20 years of vibration experience. Send for Bulletin 616A which tells more.

MB manufacturing company
A Division of Textron Inc.
1074 State Street
New Haven 11, Conn.

HEADQUARTERS FOR PRODUCTS TO ISOLATE VIBRATION...TO EXCITE IT...TO MEASURE IT.

Pacific Process Pump **EXTRAS** bring **EXTRA PROFITS** to you!

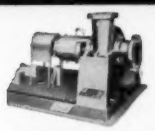
EXTRA CORROSION ALLOWANCE—All Pacific Process pumps are custom-built with case casting thickness in excess of actual pressure-temperature requirements. This provides a liberal allowance for corrosion-erosion and a high safety factor.

EXTRA HEAVY CONSTRUCTION—Pacific process pumps are engineered to combine the strength necessary for continuous heavy duty service with design simplicity and accessibility for low maintenance cost. All parts in contact with pumped liquid may be fabricated from any commercially available ferrous or non-ferrous metal.

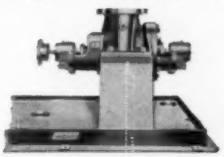
EXTRA LONG LIFE—Guided inlet flow reduces friction losses—insures minimum required NPSH. Dynamically, radially, and axially balanced moving parts eliminate vibration that would cause damage to rings, bushings, bearings, packing or mechanical shaft seals and excessive radial and thrust loads on bearings. Result—greatly increased availability for profitable operation.

Write for bulletins—please specify pump type.

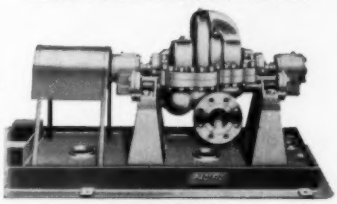
MAXIMUM PARTS INTERCHANGEABILITY
is an extra feature in
PACIFIC PROCESS PUMPS



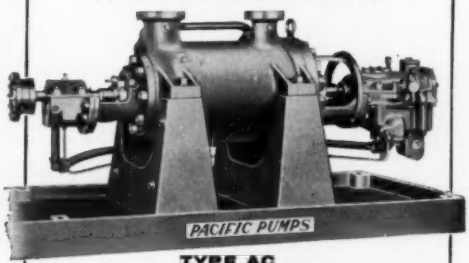
TYPE SVC
To 850°F.—25 to 3200 GPM
To 600 PSIG—To 650 DIFF. HD. FT.



TYPE HVC
To 850°F.—600 to 4500 GPM
To 600 PSIG—To 1000 DIFF. HD. FT.



TYPE RHC
To 500°F.—50 to 3000 GPM
To 700 PSIG—To 1300 DIFF. HD. FT.



TYPE AC
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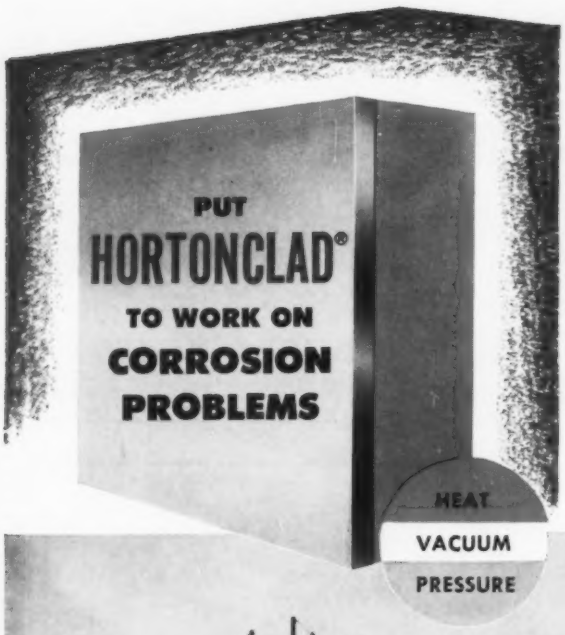

High-Strength Bonded Clad Material Described in New CB&I Bulletin

Hortonclad is a corrosion-resistant composite metal having an integral and continuous bond of exceptionally high strength produced by a special high-vacuum bonding process. Available only in CB&I-fabricated tanks, pressure vessels and other clad structures, Hortonclad provides uniform thickness because cladding and backing plate are both in their final thickness prior to bonding.

The Hortonclad process employs silver, stainless steels (both chromium and nickel) nickel and alloys such as Monel, Inconel, Hastelloys B and F and a variety of other metals and alloys.

Write our nearest office for a copy of the CB&I bulletin which describes these benefits of HORTONCLAD:

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Two crude columns (left) and vacuum column (right) were partially clad using Monel Hortonclad and stainless steel. Crude columns are 174-ft. high. Vacuum column is 28-ft. in dia. at widest point and 125-ft. high.

P71-C

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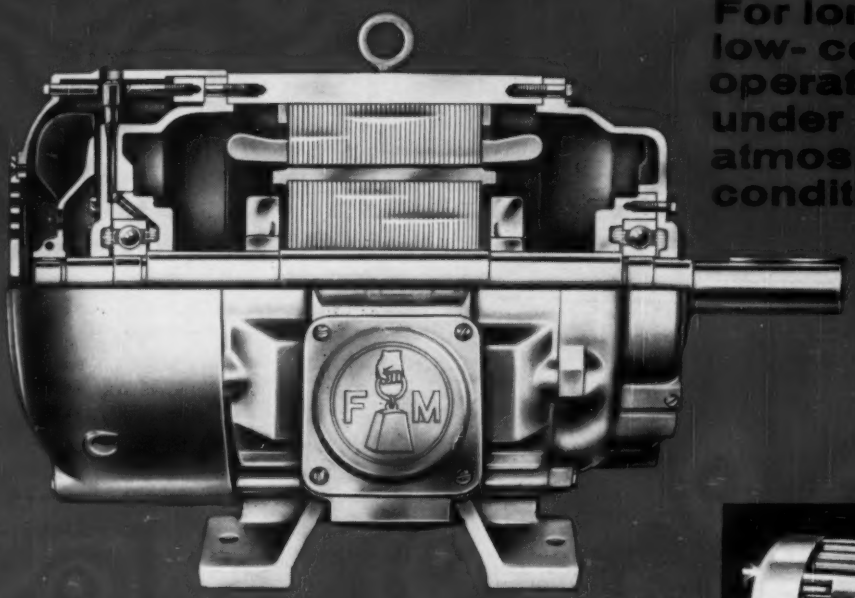
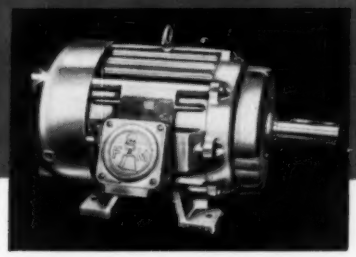
Here Is Your Motor

For long-life, low-cost operation under adverse atmospheric conditions





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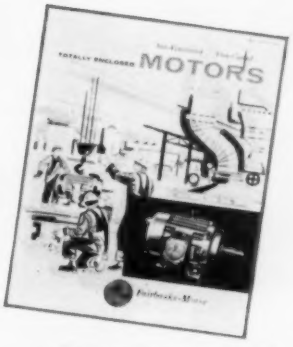
Fairbanks-Morse Totally-Enclosed Fan Cooled With Controlled-Stream Air Flow!

New Fairbanks-Morse design confines air stream to surface of motor—provides extremely efficient cooling, prevents dust and dirt accumulation. Combines advanced design innovations with long-proven F-M features.

See why these all-new F-M motors warrant your investigation *now* for severe service involving dirt, dust, metal turnings, or abrasive particles; corrosive vapors, steam, excessive moisture, etc.

Write today for new Bulletin 1205, giving complete information on new F-M Totally-Enclosed Fan-Cooled (Type KZC, in larger frames) and Non-Ventilated Motors (Type KZE, in smaller ratings). Fairbanks, Morse & Co., 600 So. Michigan Ave., Chicago 5, Ill.



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For full information, write for Bulletin 3720-A.

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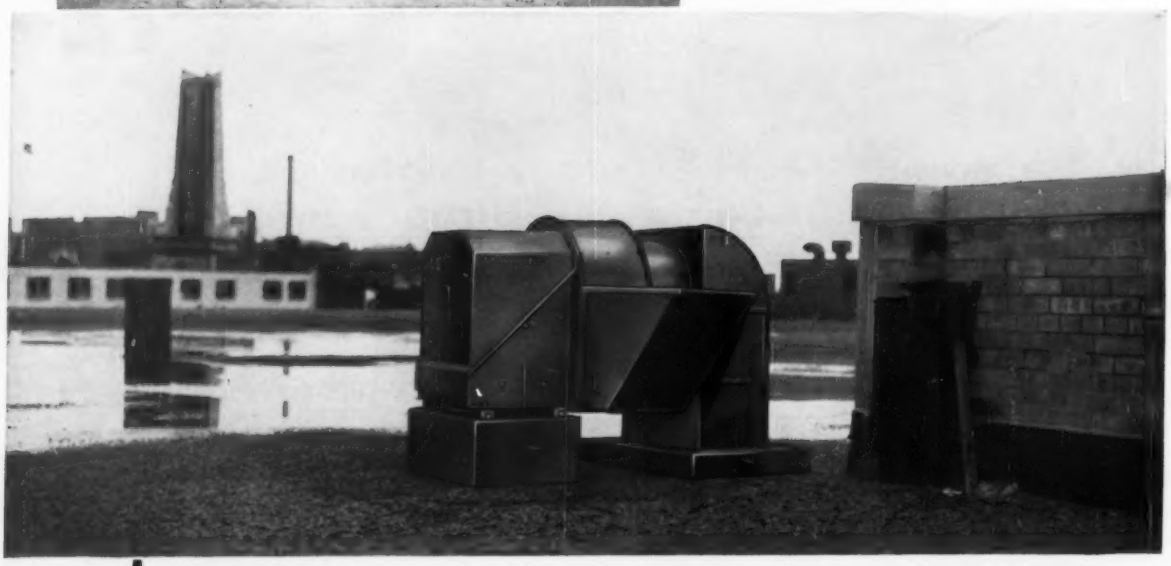
All-Weather Cover and Rain Shield. Drain Connection in bottom fan housing. Access Door in scroll. Inlet and Outlet Screens. Non-sparking Aluminum Wheels. Enclosed or Explosion-Proof Motors. Ball Bearing Motors. Anti-Vibration Pads. Stainless Steel or Aluminum Construction for Units having all parts in contact with gas or fumes. Belt Guard. Gravity Type, Hand-Operated or Motor-Operated Outlet Shutters. Special Protective Coatings on Inside Housing and Wheel.

All "Buffalo" products feature the famous "Q" Factor—the built-in Quality that assures trouble-free satisfaction and long life.



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"Buffalo"

NOT ONE FIELD CUT

in all This

MIDWEST

Shop-Fabricated Piping

...under a subcon...
and I would like to say the West Coast Division have on this job complied fully with the high standards of workmanship for which Midwest is known.

Throughout this entire project not once was a cut necessary to correct any piece of fabrication, and I might add in several instances close tolerances had to be met.

The above was not written on an impulse but as construction superintendent, this means but one thing: fast and low cost erection. Would appreciate your thanking Midwest personally for ...om a construction

Excerpt from letter by:
HOLMES & NARVER • Engineers-Constructors
828 South Figueroa St. • Los Angeles 17

Note particularly the words "*fast and low cost erection*" in the above letter. They characterize Midwest Shop-Fabricated Piping . . . whether for refinery, power plant or industrial installations. In this instance they were written by A. H. Chamberlain, construction superintendent, upon completing the installation of a Houdriformer Unit at the U.S. Oil & Refining Co., Tacoma, Washington.

There are three well-equipped Midwest pipe fabricating shops located to serve economically all sections of the country. Each is staffed by a highly skilled organization using the latest techniques. Each has wide experience on all kinds of projects so that the possibilities and limitations of all piping materials are well understood. You too will find it to your advantage to call in Midwest whenever you need fabricated piping.

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8033

How ductile iron solves the hub of a problem

Ductile iron hubs for Koppers heavy-duty industrial fans in service 7 years... no failures

These fan hubs are made for high stresses in long term operation. They are exposed to water vapor and heated air (up to 200°F) which speed oxidation; constant vibration which causes fatigue. And sometimes fly ash and sand which cause abrasion.

How would you build an economical fan hub to withstand all of these conditions?

The Koppers people had the right design. And after evaluating many cast metals, they had the right material, too . . . ductile iron.

Here's how ductile iron worked with their design: In foundry, complex castings were produced with ease. The machinability of ductile iron stepped up finishing. Lathe and drilling speeds were increased. Breakage and rejections were minimized.

As for product advantages, ductile iron had the high strength and toughness: a minimum tensile strength of 60,000 psi, yield 45,000 psi, elongation 10%. Performance speaks for itself: after 7 years operation of over 5,000 fans, no hub failures of any kind.

6 types of ductile iron are available to meet *your* specific design requirements. They have tensile strengths that range from 60,000 to 150,000 psi with elongation ranging from 5% to more than 20%. And all possess resistance to wear, shock, elevated temperatures, to permit replacement of costlier materials without sacrificing product performance. Why not get more information. Request your copy of "Ductile Iron Digest." Write:

THE INTERNATIONAL NICKEL COMPANY, INC.
67 Wall Street INCO New York 5, N. Y.

ductile iron... for high strength and toughness in iron castings.

MECHANICAL ENGINEERING

VOLUME 80 • NUMBER 7 • JULY, 1958

Parliament of Science

How shall the United States keep abreast of the developments in science and scientific technology? How shall it help avoid disaster? How shall it insure that new knowledge will be used for the benefit of mankind in general and its citizens in particular? These are some of the most important questions before the American public today.

To answer them, the American Association for the Advancement of Science held a Parliament of Science on March 15–17, in Washington, D. C., at which a representative group of more than 100 American scientists and public leaders were in attendance. The purpose: To consider current and pressing problems of the support of science and the improvement of education.

These five main topics were considered by the Parliament of Science: (1) The Support of Science, (2) Organization and Administration of Science in Government, (3) Communication Among Scientists and Communication of Scientific Ideas, (4) The Selection, Guidance, and Assistance of Students, and (5) The Improvement of Teaching and Education.

A great number of conclusions were reached, but underlying these specific conclusions are the following smaller number of important general principles upon which the participants agreed:

1 Scientific endeavor is one phase of human intellectual effort; the degree to which it flourishes depends largely upon the extent to which intellectual effort generally is supported and encouraged.

2 Optimal progress in science requires increased support for basic research.

3 As funds for the support of science increase, it becomes increasingly necessary to formulate appropriate plans and procedures for the administration and correlation of the total scientific effort and to give closer scrutiny to national scientific policy.

4 In order that science may progress most effectively, and in order that science may be wisely used for the improvement of human welfare, scientists must have the maximum possible freedom to communicate with each other, both in person and by publication, and to communicate with the public.

5 Scientists are dedicated to the finding of new knowledge. As citizens, they have the responsibility to concern themselves with the social consequences of their scientific findings and to inform the public of the consequences they foresee.

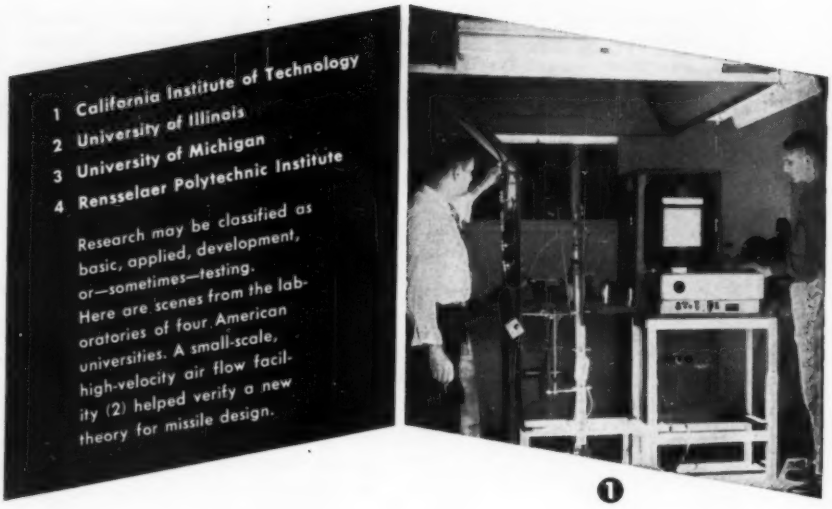
6 The primary goal of education is the intellectual development of the individual. The primary need of education is to improve quality and to raise standards—of teachers, of curriculums, and of what is expected of students.

7 In the assignment of funds to the improvement of education, first priority should go to improvements in curriculums, teaching, and the status and salaries of teachers.

The entire report of the 1958 Parliament of Science, which is highly illuminating, appears in *Science*, April 18, 1958. Scientists and engineers are urged to read this report as it emphasizes the need for a more understanding collaboration between their special profession and the rest of society. At the same time it stresses the urgent need for society to understand the scientists' problems and their implications.—*J. J. Jaklitsch, Jr.*

Editor, J. J. JAKLITSCH, JR.
Editor Emeritus, GEORGE A. STETSON

In the wake of the artificial satellites, the nation is taking stock of its procedures and achievements in science and engineering. At the level of the graduate student, education becomes a process of independent and creative thinking, the student's thesis making an original contribution to the field of knowledge of his choice. The Engineering College Research Council works to co-ordinate this research.


1 California Institute of Technology
2 University of Illinois
3 University of Michigan
4 Rensselaer Polytechnic Institute
Research may be classified as basic, applied, development, or—sometimes—testing. Here are scenes from the laboratories of four American universities. A small-scale, high-velocity air flow facility (2) helped verify a new theory for missile design.

RESEARCH AND HIGHER EDUCATION

By R. G. Folsom,[1] **Fellow ASME**

President, Rensselaer Polytechnic Institute, Troy, N. Y.

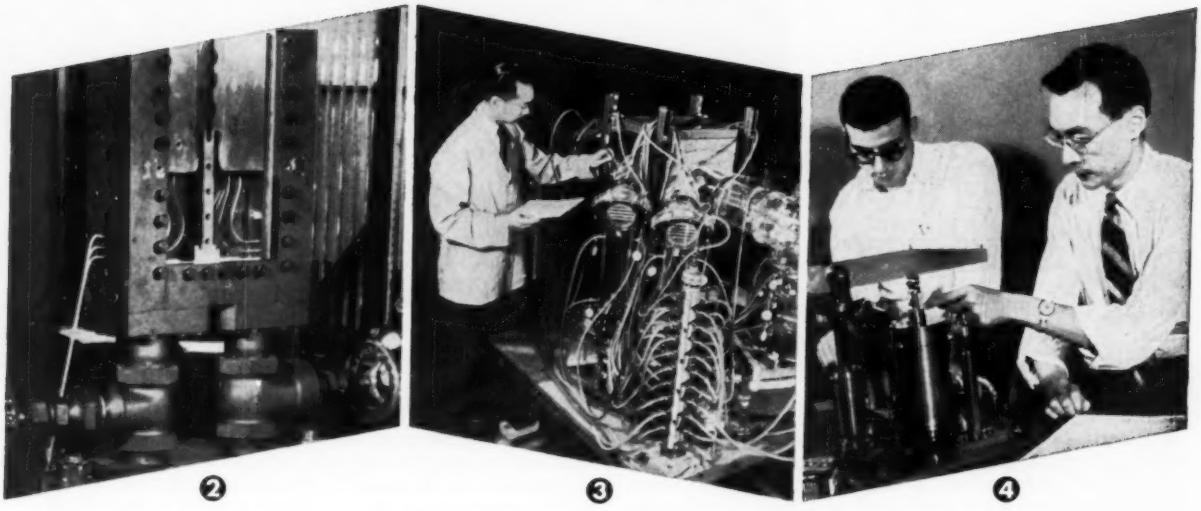
It is the purpose, here, to discuss research activities at American schools in mechanical engineering—research associated with advanced-degree work at the Master of Science and PhD levels, as well as the personal research activities of the teaching faculty members and full-time research employees of the educational institutions.

A definition of research might run about as follows: It is the process of doing something about something that nobody knows anything about, or, in other words, research is the process of investigating the unknown. These unknown factors may cover a wide range of interest, such as the development of abstract ideas associated with the design of digital computers, theoretical investigation into the metallurgy of steels, experimental investigations of heat transfer and fluid-flow characteristics of gases flowing at high velocities, the discovery of new parts, equipment, or processes to improve present operating units.

Subdivisions of Research

There has been a great deal of discussion attempting to explain and define the different kinds of research that might be classified under basic, fundamental, applied, developmental, and similar adjectives. Experience has indicated that applied research in one field might be considered basic research in another. For example, to the mechanical engineer the development of the fundamental design data on the performance of new materials might be considered basic, while from the standpoint of a scientist such work would be applied research. From

[1] Formerly Director, Engineering Research Institute, University of Michigan, Ann Arbor, Mich.



the engineering standpoint, the most important fact with respect to these possible divisions of research is that actual research operations frequently involve some phases of basic and applied research and development. In almost all operations, applied research and development are necessary to solve problems in basic or fundamental research.

Definitions might be: Basic (fundamental) research is that kind of activity in which the objective is to determine the true facts only; applied research is that activity associated with obtaining new information which will be of general importance to a specific field of activity. Development research is that activity associated with producing a new product or piece of equipment to meet a specified objective. Testing is the collection of information under controlled conditions. It should be noted that testing is not generally considered as a research activity, and frequently development has no research basis.

There are many areas in mechanical engineering where the information available is so fragmentary in nature, or the complications are so manifold, that a testing program may be necessary as a preliminary to a basic research investigation, and in this case such a program is frequently considered as a part of the investigation. The important difference between testing and research lies in the fact that, although the test results may be new information, they will be of extremely limited value unless that information can be correlated with known variables and/or placed in a logical theory. Research involves an analysis and development over and above that required for routine testing.

One might ask: Why is a university interested in doing research? An engineering student, particularly in the undergraduate days, learns a series of fundamentals and the application of those fundamentals to the solution of certain problems, and receives an introduction to some development activities. To a large extent, undergraduate activities are associated with the absorption of knowledge and the development of a skill as a basis for future work and thought.

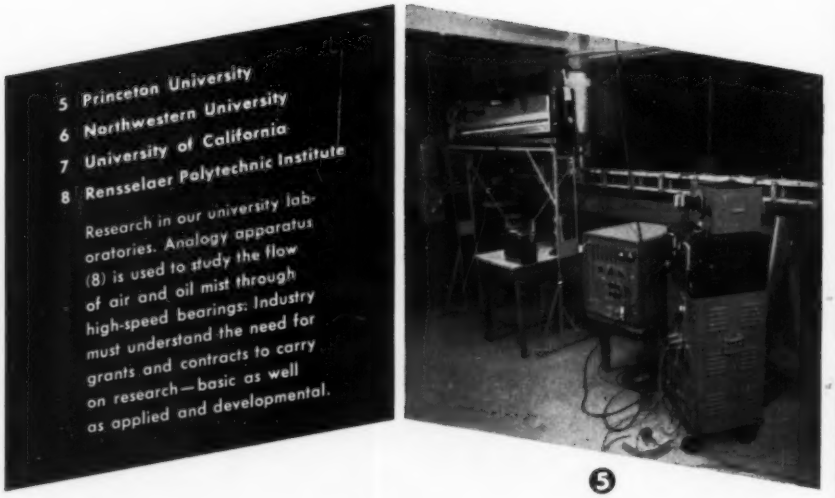
The Graduate Student

If the educational institution wishes to undertake graduate study, it must recognize that the primary characteristic of graduate study which differentiates it from undergraduate study is the development of independent and creative thinking on the part of the student. This is formalized usually by the development of a suitable thesis, frequently at the Master's level and almost uniformly at the doctoral level, such a thesis constituting an original contribution to the field of knowledge of the student's choice. Research is a part of the requirements for graduate study. The American Society for Engineering Education in the "Manual for Graduate Study in Engineering," recommends that "not less than one third of the major allotment in a doctorate program be devoted to research," and again, "A greater time to be spent on research is to be encouraged for any student who shows early acceptance of complete responsibility for the use of his time when it is undirected." Experience at the leading educational institutions indicates that it is desirable for the faculty to engage in significant research work to provide an adequate basis of creative instruction.

Research as a Career

The portion of engineering graduates entering the fields

RESEARCH AND HIGHER EDUCATION


5 Princeton University
6 Northwestern University
7 University of California
8 Rensselaer Polytechnic Institute
Research in our university laboratories. Analogy apparatus (8) is used to study the flow of air and oil mist through high-speed bearings. Industry must understand the need for grants and contracts to carry on research—basic as well as applied and developmental.
5

of research and development has increased tremendously during the past 30 years. It has been estimated that in the late 1920's from three to five per cent of the engineering graduates entered this kind of activity. A recent survey by the National Science Foundation indicates that in 1955 at least 25 per cent of our engineering graduates were going into the research and development fields.

During 1953–1954, the National Science Foundation estimated ("Basic Research—A National Resource," NSF 57-35) that industry-oriented institutions, colleges and universities, other nonprofit institutions, and federal government agencies spent about $5.4 billion for research, of which approximately eight per cent was basic or fundamental research. It was also found that the colleges and universities did about nine per cent of the total research performed, and of this amount, only about one third was financed by college and university funds, the remaining two thirds coming from sources outside the educational institutions.

The majority of the research work in the colleges and universities could be classified in the basic and fundamental research areas. If it is desired to increase the research output of our schools and colleges, further support from outside agencies will be necessary, since the resources of almost all our institutions of higher education are already sorely taxed and will be more inadequate than ever to meet the student-load increases during the next 15 years.

To handle most efficiently grants, contracts, and other types of support for research activities, many educational institutions have established units for administering such research grants and contracts. These administrative units for engineering generally follow the policies stated in "A Suggested Research Policy for the Guidance of Engineering Schools":

"It is to be expected that the research program of an engineering school should properly embrace the following types of activities:

1 Research to discover basic or fundamental scientific principles and facts which will advance the science of engineering.

2 Applied research or development of specific devices or processes which will develop the competence of the teacher and the student, thereby serving the engineer in a manner parallel to the clinical studies of the physician.

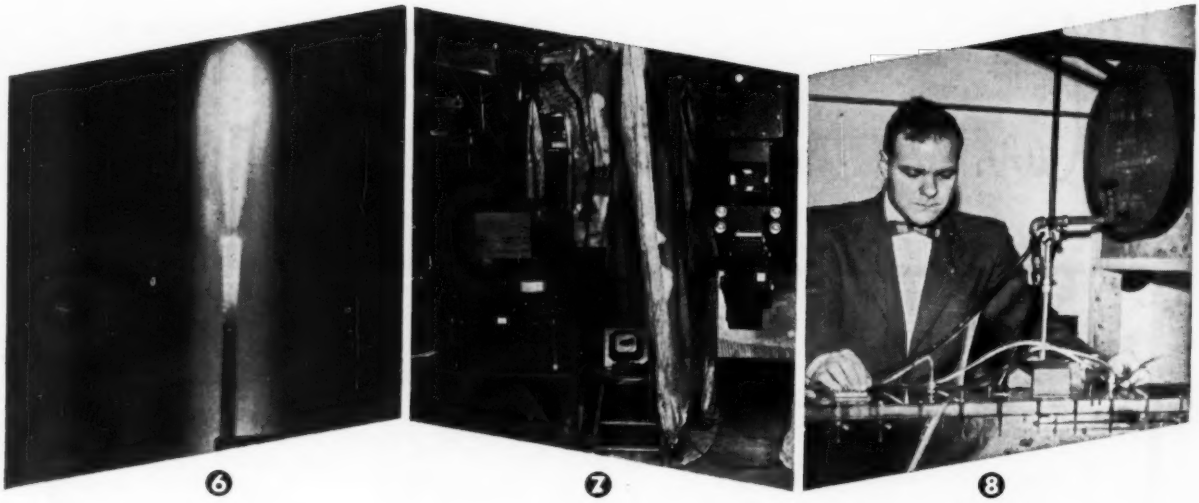
3 Activities which serve the public interest, as for national defense, public health, or general industrial and agricultural progress."[2]

The ECRC

In order to provide an over-all picture of research at our leading educational institutions, the Engineering College Research Council (ECRC) has recently published *Engineering College Research Review*, 1957,[3] summarizing the work done at 109 institutions during 1957–1959, representing an expenditure of about 100 million dollars, and employing 15,000 technical people. This volume contains more than 5000 entries, of which a little more than 900 may be classified as being in the field of mechanical engineering. In addition to listing the titles of research projects being undertaken at the various educational institutions, the volume includes a history of the Engineering College Research Council, the research officers, the research policies, and research expenditures at each institution. It is the most complete source available for engineering research activities in American educational institutions.

"The *Review* provides a unique source of information to all those who are in engineering college research so that they can know of the research conducted elsewhere which is similar or related to their own interests. . . . The engineering colleges themselves can benefit from the knowledge here displayed of the policies applicable to research and of the research programs at other institutions." Also, "In engineering teaching, continual contact with the forefront of engineering and scientific progress is essential. . . . The engineering teacher carries a responsibility to contribute to the advancement

[2] *Journal of Engineering Education*, Oct., 1954.
[3] To be obtained from Renato Contini, Secretary, ECRC, New York University, University Heights, New York 53, N. Y. Price, $2.



6 7 8

of knowledge through engineering research. The university must provide the opportunity to realize this objective in terms of time, facilities, and assistance." (Foreword to *Engineering College Research Review*). The importance of research participation to the individual faculty member is indicated in the 1955 ASEE "Report on Evaluation of Engineering Education."

Classifying the Projects

Computers, both analog and digital, are important new facilities available to the engineer. To learn how many projects of the approximately 5000 entries listed in the *Research Review* dealt with analog computers in the field of mechanical engineering, its "Index to Research Projects" was examined. The entry "Analog Computer(s)" had 30 page references, which yielded 48 specific projects having the words "analog computer(s)" in the title. The distribution of these project titles over the various fields of engineering is shown in the following: Electrical engineering, 33; chemistry and chemical engineering, 4; mechanical engineering, 3; computer centers, 3; mathematics, 2; aeronautical engineering, 1; civil and sanitary engineering, 1; engineering, 1; total, 48.

This analysis would indicate that there were 48 separate research programs involving analog computers in the 109 ECRC schools. A further analysis indicated that no research project at The University of Michigan contained the words "analog computer" in the title. Yet, there were nine projects at The University of Michigan that were associated with the theory, development, or use of analog computers. This example is given to call attention to the value of the *Research Review* in locating research of a given type at the ECRC schools, and at the same time to indicate the deficiencies that may exist.

As indicated previously, research in modern science and engineering requires expensive equipment, facilities, and staff, frequently beyond those available to a specific educational institution on the basis of its normal budget. In addition, it must be recognized that, if we are to expand the fundamental research activities in the higher educational institutions, financial support must become available from sources external to the institution.

Liaison With Industry

To help industry understand the needs of educational institutions with respect to grants and contracts for research support, the ECRC is preparing a pamphlet to assist industrial organizations and educational institutions who wish to co-operate in research activities for mutual benefit. This pamphlet will include a discussion of the objectives of research in industrial and educational organizations, the research operations at educational institutions, and suggested items for consideration in a sponsored research project contract.

Frequently, the professional mechanical engineer is at a loss to propose examples of fundamental research in the field of mechanical engineering. As an example of such activities, the research projects listed in the *Research Review* under the University of California, Berkeley, for mechanical engineering, show that, for example, the field of fundamental heat-transfer investigations included: gaseous radiation; boundary layers; clothing; very low pressures and supersonic velocities; gas-solids systems; forced convective boiling; radiant heating and cooling; coiled pipes; subcooled nucleate boiling; total emissivity; local measurement; and liquid-metal convective heat transfer. It is expected that, in due course, many, if not the majority, of these investigations which produce significant research results will be submitted as papers before ASME meetings and published in *Transactions of the ASME*. In fact, the engineer who is puzzled about basic research in mechanical engineering would do well to study *Transactions* (including the *Journal of Applied Mechanics*) for a year, since this publication contains many papers of fundamental nature and of lasting interest.

Fundamental research is an investment in the future that must be supported by all engineers. It is particularly important to mechanical engineers who want to lead in their fields. Have you given any thought to how you are upholding fundamental research in mechanical engineering?

By **A. O. Radke**, Assistant Director,
Bostrom Research Laboratories, Milwaukee, Wis.

Man's new environment... VEHICLE VIBRATION

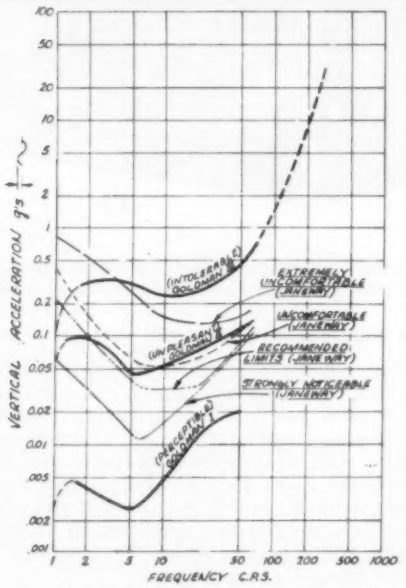


Fig. 1. Human reaction to vertical-vibration-mean thresholds by Goldman (8) and Janeway (7)

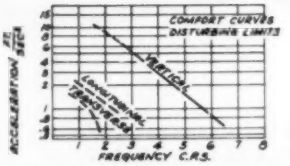


Fig. 2. Human reaction to vibration, Jacklin (2)

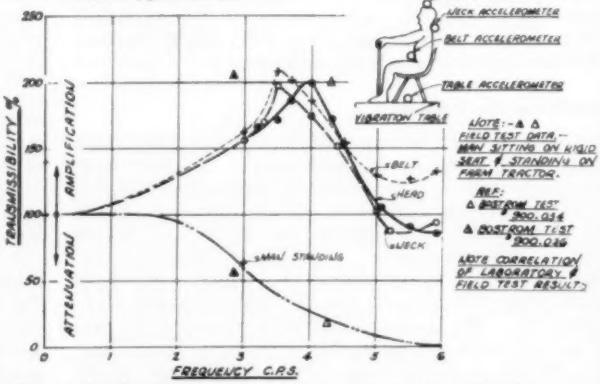


Fig. 3. Mechanical response of man to vertical vibration

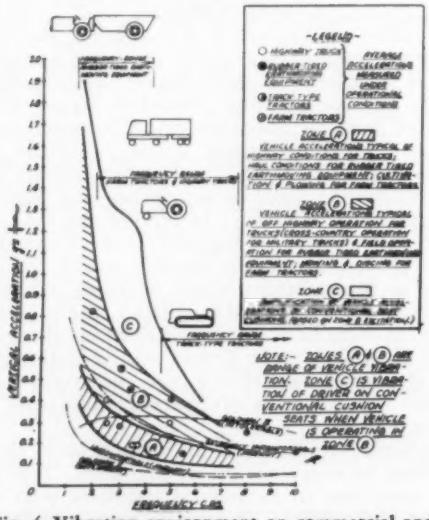

VERTICAL ACCELERATION g's
FREQUENCY C.P.S.
ZONE (A)
ZONE (B)
ZONE (C)
NOTE:- ZONES (A) & (B) ARE RANGE OF VEHICLE VIBRATION. ZONE (C) IS VIBRATION OF DRIVER ON CONVENTIONAL CUSHION SEATS WHEN VEHICLE IS OPERATING IN ZONE (B)

Fig. 4. Vibration environment on commercial and military vehicles

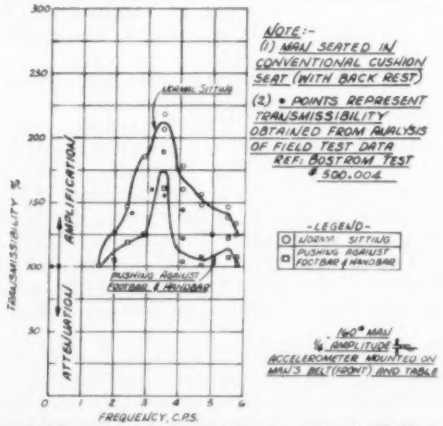

TRANSMISSIBILITY %
AMPLIFICATION
ATTENUATION
FREQUENCY, C.P.S.
NORMAL SITTING
PUSHING AGAINST FOOTBAR & HANDBAR
NOTE:-
(1) MAN SEATED IN CONVENTIONAL CUSHION SEAT (WITH BACK REST)
(2) • POINTS REPRESENT TRANSMISSIBILITY OBTAINED FROM ANALYSIS OF FIELD TEST DATA
REF: BOSTROM TEST 500.004
LEGEND
NORMAL SITTING
PUSHING AGAINST FOOTBAR & HANDBAR
ACCELEROMETER MOUNTED ON MAN'S BELT (FRONT) AND TABLE

Fig 5. Effect of sitting position on transmissibility

Human tolerance to vibration and the resulting decrease in efficiency have been ignored in designing many commercial and military vehicles. Medical surveys show that serious physical disorders result from continued exposure, yet little consideration has been given to vibration in engineering design.

THE "occupational" exposure of man to vehicle vibration affects the health and well-being of the individual and the performance of the machine. Military and commercial vehicles of all types are man-machine systems, directly analogous to servomechanisms—but with human controllers. These controllers are called upon not only to start, guide, and stop the mechanism, but to make computations and give direction under widely varying conditions.

Nearly everyone is exposed to vibration—at least as a passenger in an automobile—although the automobile is the least offender as far as ride vibration is concerned. On trucks, tractors, and other military and commercial vehicles, man exists principally to accomplish the machine function. To this extent, his comfort and even his efficiency have often been incidental to, or at best, the least consideration in, the design of the machine.

These considerations make exact knowledge of the vibration environment to which man is exposed, his tolerance to vibration, and the consequences or cost of exceeding them important and necessary.

Man's Tolerance to Vibration

Present knowledge of man's tolerance to vibration is largely in terms of his subjective reaction to steady-state vibration.

Investigations made both in Europe and in the United States have developed the general pattern of tolerance (1 to 6).[1] The effect of motion in each direction separately has been investigated, but little has been done for combinations of motion, although Jacklin has proposed vector summations and corresponding indexes of comfort. Several efforts have been made to combine the data of these various investigations and to establish limits or recommend allowable vibration intensities (7, 8). The recommendations and suggested thresholds for at least the vertical direction are shown in Fig. 1. Data for the transverse and longitudinal directions are much less complete; however, Jacklin does show that man in a seated position has considerably less tolerance of vibration in the transverse and longitudinal directions than in the vertical, Fig. 2.

Man's dynamic behavior, or mechanical response to vibration, has been studied in relation to the subjective reaction to vibration (5, 6). Fig. 3 shows the dynamic characteristics of man both seated and standing. It is significant that, when seated, he exhibits a resonance or maximum amplification near 4 cycles per second (cps); while standing he has the ability to attenuate or to insulate himself against vibration, particularly above 3 cps. The amplification at 4 cps is characteristic of all subjects studied.

The amplification of the various parts of the body may vary with the subject's tenseness and may vary between individuals, some exhibiting much higher amplifications for the head and upper torso than that shown in Fig. 3. The field-test data plotted in Fig. 3 show that the data have more than laboratory significance.

The relation between the resonant frequency of man and higher perceptibility of vibration exhibited by man at this frequency is shown by the curves in Fig. 1.

Occupational Studies

Important as these data are on tolerance to vibration and mechanical response, they tell very little in terms of performance or the effect on health and comfort. While they attempt to establish limits, they do not spell out the costs of excessive vibration.

Some general but important evidence of the physiological damage and cost of vibration has been developed by medical surveys of people in occupations connected with driving or operating "rough-riding" vehicles. The results of even these limited studies reveal the seriousness of the problem. The following excerpts are typical:

"A survey of orthopedic surgeons in the United States definitely establishes that riding on trucks or tractors either causes or aggravates a number of disorders of the spine and supporting structures of drivers.

"With more than 10 million trucks and tractors being operated in the United States, exclusive of those in the armed forces, the health hazards of driving such vehicles constitute a major medical problem that is not receiving the attention and study it deserves, either by the medical profession or the manufacturers of such equipment" (9).

"The writer has examined officers compelled to ride for prolonged periods of duty in jeeps, over rough roads, and such officers have developed severe lower back pains causing retirement from the service with substantiated diagnosis of intervertebral disk, hernia or rupture, operative procedure being required in some cases" (10).

While the implications of both the laboratory and field studies are apparent, the actual cost in terms of health and impaired performance is undetermined. Investigations in these areas are necessary and overdue.

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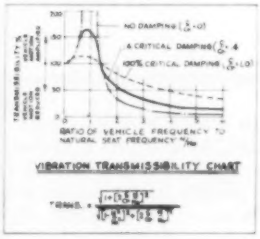
[1] Numbers in parentheses refer to the Bibliography at the end of the paper.

Contributed by the Management Division and presented at the Annual Meeting, New York, N. Y., December 1–6, 1957, of THE AMERICAN SOCIETY OF MECHANICAL ENGINEERS. Condensed from Paper No. 57—A-54.

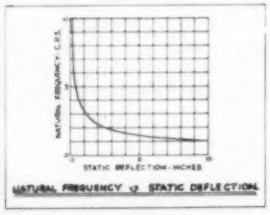
Man's new environment...

VEHICLE VIBRATION

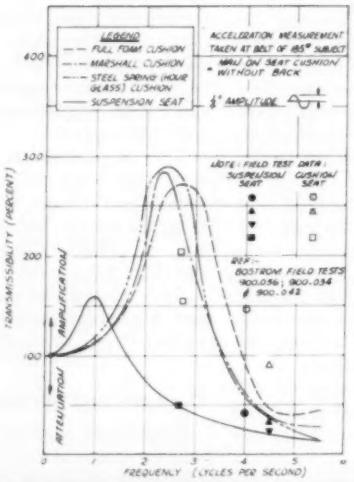
▼ **Fig. 6 Vibration transmissibility chart**



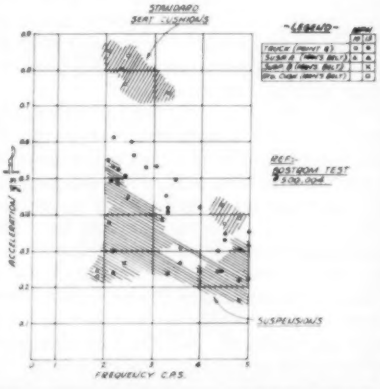
▼ **Fig. 7 Natural frequency versus static deflection**



▼ **Fig. 8 Effect of seat construction on transmissibility**



▼ **Fig. 9 Vertical average acceleration versus average frequency for truck (standard vertical position) and driver (belt) in suspension A, suspension B, and with standard seat cushion**



The Vibration Environment

Automobile drivers and passengers aside, some 15 million Americans each day ride or operate vehicles which have a relatively high vibration intensity. These vibrations result from the terrain and the dynamic reaction of the vehicle, and from the engine and induced vibration of the vehicle components. While all are important to man, the higher frequencies (above 10 cps) are easily and generally attenuated. For this reason, only vibrations under 10 cps are considered to be a ride problem.

The dynamic behavior of vehicles is mathematically—but complexly and laboriously—predictable. Electronic-vibration-measuring and recording equipment have made actual measurement of the vehicle and the driver vibration under field conditions practical, and perhaps more satisfying.

Seismographic measurement of vibration is fairly easily accomplished. The recorded traces can be analyzed for both the frequency and amplitude content on both the vehicle and the driver.

An analysis of similar data for a variety of vehicles under normal operating conditions has been made, and the general pattern of vehicle-vibration intensity and frequency is shown in Fig. 4. Zones A and B are the range of accelerations for the vehicles. Zone C represents the vibration as measured on the operator or driver when subjected to the vibration intensities in Zone B The higher intensity levels measured on man are the result of the amplification of the vehicle motion by the more or less standard seating—principally seat cushions.

Zones A, B, and C combined represent man's vibration environment on at least the most common commercial and military vehicles. To reference these intensities in terms of man's tolerance to vibration, the various thresholds established by Goldman and Janeway are also shown in Fig. 4.

It is quite apparent that man is exposed to vibrations where he is vibrated at levels of intensity above the so-called uncomfortable or unpleasant thresholds, and is frequently exposed to vibration intensities above even the so-called intolerable and extremely uncomfortable levels.

Vibration Attenuation

The consequences of seating a man on a vehicle are twofold: (*a*) He is robbed of his own natural vibration attenuators—his legs; (*b*) the seat provided, for the most part, has amplified the vehicle motion.

Fig. 5 shows the dynamic characteristics of a conventional seat taken from a current-model truck in transmissibility versus frequency. The transmissibility was determined by measuring the motion of the man seated on the cushion and comparing it to the exciting motion.

It is quite obvious in this situation that man is experiencing vibration amplitudes equal to or greater than those of the exciting motion. If the frequency range in which this amplification occurred is compared with the frequency ranges of the various vehicles, as shown in Fig. 4, it can be deduced that man will experience similar amplification in a majority of our present commercial and military vehicles.

Man on a seat is analogous to a sprung mass and obeys the same laws of vibration dynamics. They are: (*a*) In order to achieve isolation, the natural frequency of the mass on the spring must be lower than the exciting frequency (that is, that of the vehicle) by a factor of at least the square root of 2; (*b*) the natural frequency of the man or mass on the seat or spring is a function of the spring rate of the system, which for a linear system is governed only by the deflection of the spring by the mass. These two laws are illustrated in Figs. 6 and 7.

Recognizing these, it can be shown that a seat designed only for static comfort will permit a deflection of only several inches and that this deflection will fix the dynamic characteristics of the seat and produce the result very much like that shown in Fig. 5.

That this is true regardless of the particular internal construction of the cushion is shown in Fig. 8 which compares the dynamic characteristics of three cushions representing very common construction.

Since they are designed principally for static comfort which, in turn, establishes the amount of deflection of the man into the cushion, the dynamic characteristics are essentially the same. If sufficient deflection of the man into the cushion were permitted (that is, on the order of 10 in. to achieve some degree of isolation), the cushion would be ridiculously soft and statically uncomfortable.

Insulation from Vibration

The solution to the problem lies in the insulation of the man from the basic vehicle vibration. Separation of the dynamic and static qualities of the seat is the apparent first step. The mechanism by which the man is isolated from the vehicle vibration is called the suspension. The suspension principle may be applied to the seat, or to the entire operator area, or to the vehicle, as is done in the case of passenger automobiles. The last two are obviously more expensive and, in many cases, impractical because of the operational requirements of the vehicle.

Adequate suspension seat design requires a suspension natural frequency sufficiently below that of the vehicle frequencies to attenuate the vibration and shock.

While vibration and shock are often considered as separate problems, they frequently have a common solution. Dynamically, they are similar and differ largely in degree. The practical application of a suspension mechanism to a seat requires a method of "preloading" in order to keep the space requirements within reasonable limits, to accommodate a range of drivers' weights, and to provide reasonable driver-control relationships. Preloading is simply a method of placing an initial load or tension on the springs which will balance the static load of the driver and bring the system into static equilibrium at some predetermined point.

A laboratory comparison of the dynamic characteristics of a suspension seat with conventional seat cushions is shown in Fig. 8. That the differences between conventional seat cushions and suspension seating, as shown in Fig. 8, are valid in actual vehicle application is shown in Fig. 9 and by the points identified as field-test values in Figs. 5 and 8.

While the field-test values are actually average accelerations plotted at average frequencies, they are sufficiently representative to at least confirm the theoretical and laboratory predictions.

Even with present suspension seating, however, the vibration intensity may still be greater than the recommended limits proposed. To meet these recommendations would increase the cost not only of the seat but of the vehicle. As the cost of achieving the recommended limits increase, the validity of the limits becomes of great importance. More exact knowledge is needed of the physiological cost, effect on performance, and the effect on the health and morale of the operator. To this end, a considerable study has been initiated to measure at least the physiological and psychological factors that affect man exposed to vibration. It is hoped that the development of these basic data will enable designers to make maximum and effective use of man's ability. Effective manpower is perhaps our most precious and limited resource.

Acknowledgment

The author is grateful for the assistance of A. K. Simons and W. C. Oswald of the Bostrom Research Laboratories in the preparation of the paper.

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The engineer is more than a technician:
He is the man who creates new things.
Here, educators discuss engineering education.

Tomorrow's Engineer[1]

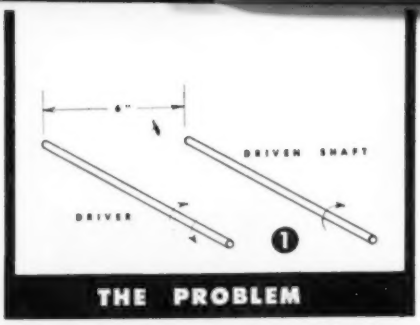


Fig. 1 A sophomore problem: Make the driven shaft rotate always in one direction while the driver may turn either way. Elementary creative engineering.

Teaching Creative Engineering[2]

THE problem is to teach engineering, as distinguished from the basic and engineering sciences on the one hand and the technical skills which support engineering on the other.

The goal of engineering courses should be to develop capacity for dealing with both creative and analytical problems, to integrate the basic and engineering sciences, and to instill a professional attitude characterized by willingness to exercise judgment, to make decisions, and to accept responsibility.

Successful college methods all involve the student's working at the highest level of which he is capable on a series of realistic engineering problems, individual projects, or a thesis. The project or problem work may be incorporated in the engineering science courses; or there may be separate problem courses whose sole function is attainment of the afore-mentioned goals and where there is no attempt to develop anything new except problem-solving ability.

These special courses are built around the solution of problems by the student on his own initiative. Some of the problems require a good deal of creative thinking while others are highly analytical.

Make That Shaft Turn

The following problem, not original with the author, was used very successfully early in the sophomore year when the students had had almost no engineering and only about half of their basic science courses.

> Design a means which will cause a driven shaft to rotate in only one direction when a driving shaft turns either way. The velocity of the driven shaft should be equal in magnitude to that of the driver. Shafts are parallel and about 6 inches apart (Fig. 1). The power to be transmitted is small. Sketch a simple device to do the job.

The students had had no instruction in mechanisms and had no convenient reference material, and thus were thrown on their own resources. The problem was given for a week's work outside of class, and so one might think there would be a great deal of collaboration. Undoubtedly notes were compared and upper classmen consulted, but this in itself has educational value. On challenging assignments such as this, students usually exhibit a high degree of professional pride in their own individual ideas, and so a wide variety of solutions results. For this problem 25 students presented solutions of five main types with as many subspecies as students.

The most common type of solution and possibly the best is shown in Fig. 2. It consisted of two oppositely directed belt drives each incorporating an over-running or one-way clutch. Variations used chains or gears.

There were a number of solutions in which gears were shifted by a screw on the drive shaft or by friction with the drive shaft. The latter is shown in Fig. 3. There were numerous schemes in which gear shifting was done electrically by solenoids energized through switches actuated by changes in direction of the drive shaft.

In addition to these mechanical drives between the two shafts, several hydraulic and electric links were presented. A hydraulic link is shown in Fig. 4.

The individual students presented their solutions to the class without the instructor having seen them first, and then the class, with guidance, classified them into main types. Next the class tried to evaluate the solutions considering such things as probable workability and reliability, and number and simplicity of parts with the attendant economic implications. At this stage it became clear that some of the solutions represented good engineering while others did not.

Some of the more complicated solutions were difficult to describe and their authors had a powerful lesson from the class on the value of being able to communicate effectively by good sketches.

A problem such as this, given at the right time, is exceedingly good education for engineering. The student has to draw on his creative powers and on all of his relevant experience; he has to be able to put on paper and communicate to others what he visualizes; and he must be prepared to defend his ideas against the criticism of his associates. Finally, in comparing the various solutions he learns for himself what is good engineering.

Problem for Seniors

A problem of a very different character that was used successfully with seniors as a week's assignment was:

> Investigate the feasibility of a windshield defrosting system for private automobiles which uses electrically conducting glass for the windshield and power from the car's electrical system.

What does the student have to do? First he must seek out the real problem or problems—something to get his teeth into—because the problem as stated is pretty vague, as is usual in real engineering situations. The student must define the problem for himself in specific terms. He has to think about what the defroster should accomplish. Drawing on his experience he might set down some situations when a defroster is needed. For example:

[1] Based on two papers contributed by the Education Committee and presented at the Annual Meeting, New York, N. Y., December 1–6, 1957, of THE AMERICAN SOCIETY OF MECHANICAL ENGINEERS.

[2] Condensed from "The Engineering in an Engineering Curriculum," by D. W. Ver Planck, Mem. ASME, Department of Mechanical Engineering, Carnegie Institute of Technology, Pittsburgh, Pa.

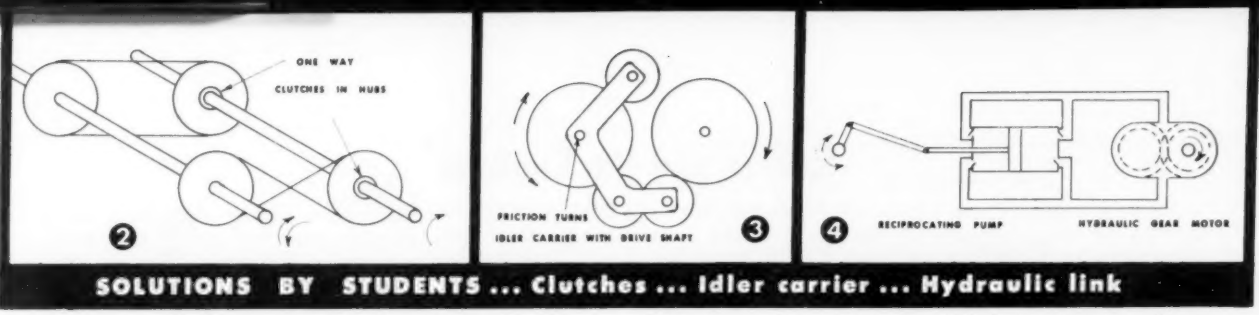


Fig. 2 The most common—and perhaps the best—solution to the first problem. Students, untrained in mechanisms, were on their own. Fig. 3 Another solution: Friction impels the idler carrier into the correct position, whichever way the driver turns. Gears were also shifted electrically. Fig. 4 Several hydraulic and electric links were presented. As the class compared solutions, students learned what good engineering is.

1 To melt ice from the outside of the glass after the car has been parked in a sleet storm.

2 To keep snow and slush from freezing on the outside when the car is being driven.

3 To keep frost or fog from forming on the inside when driving in cold weather.

The student must realize that in each of these conditions—and there are many possible combinations of them—the function of the defroster is to supply heat either to the outside or to the inside of the glass.

How much heat? The student must decide such things as reasonable numerical values for outside and inside air temperatures, thickness of ice on the glass, humidity (or dewpoint) inside the car, rate at which snow strikes the glass, and speed of the car through the air. An immature student tends at this point to assume the simultaneous occurrence of the worst possible conditions; for instance, a heavy sleet storm, six large people inside all smoking, no ventilation, and the car going at 100 mph.

The student soon finds himself faced by a problem in heat transfer and a need for making simplifying assumptions as his judgment dictates. This part of the work will involve the writing of algebraic equations and the performing of some mathematical operations which will not be dwelt on here. The conclusion of this stage of the student's work would be a numerical value for the heat required for the conditions he has assumed: For example, to keep frost from the inside in zero weather at a car speed of 40 mph requires about one kilowatt.

One kilowatt is several times the rating of the usual car generator. Thus the student may conclude from his work that the proposal is not feasible in the present state of automobile development, since the added cost of a much larger generator could hardly be justified by the small advantage of heating the windshield electrically when the conventional method, using air from the heater, is so simple and economical.

Educational Values

Why is this problem good educationally? First, it is a truly professional problem as distinguished from the usual textbook type. The student is given only a general situation and has to define a specific problem for himself. This is the way problems come to you and me in practice. The student has to supply his own numerical data based on his own experience and judgment just as we do in our problems. Moreover, the end point is not a number—the answer is not 1.2 kw—rather it is a recommendation; e.g., "This proposal is not feasible because of a large increase in generator size. Since its advantages do not appear great, I recommend abandoning the idea."

Second, the problem cuts across several sciences. Although it turns out to be largely a problem in heat transfer, thermodynamics of air-water vapor mixtures comes into it, and also some electrical engineering. The student does not know in advance what sciences will be needed; he has never worked, or seen worked, a closely parallel problem. Therefore, he must, on his own initiative, select and apply the principles he needs.

A final problem concerned an electromechanical servo system, and it is important to observe that the seniors to whom it was assigned had taken no course in servos, and, therefore, the problem was not of a type they had encountered before, but a new experience. The students had to find out for themselves that the behavior of the system could be described by means of a differential equation. This, of course, was not the first time they had derived and solved a differential equation by themselves, but this problem represented an entirely new combination of physical phenomena to be described mathematically. The students had to decide how the laws of electric circuits and of mechanics were applicable to this case and then apply them, expressing the equations in terms of variables they deemed appropriate.

The three problems which have been described differ widely from each other in amount of creativity needed and in mathematical level, but all require the student to work as an engineer with maximum freedom to exercise judgment and initiative. All require decision making.

To make room for the kind of education being discussed here and for the increased emphasis on science, some things have to be eliminated. These are: the courses chiefly descriptive of existing plants and equipment, the design courses whose content is largely drafting, and the shop courses whose objective is principally the acquiring of manual skill or know-how.

The young engineer needs to be proficient in the principles of engineering drawing—particularly he should be able to communicate by sketches—but he does not need to be an accomplished draftsman. Neither does the engineering graduate need to be a machinist or a welder. It is, of course, highly desirable for him to acquire a feel for machinery and for the making of measurements.

Conclusion

The heart of an engineering education is now, as it always has been, the learning of what has come to be called the engineering method. The method itself is not new. The new element is that mathematics and science are becoming ever more important tools. Learning to use these tools, and learning engineering method, are best done through intensive practice in solving realistic engineering problems.

Science and the Engineer[3]

THERE has always been a basic core of technical information on which engineering training has been built. Its content has varied with the growth of the profession. In recent years our engineering accomplishments have been dominated by the advances in science.

To a large degree the engineer must acquire the same understanding of natural phenomena as the scientist, but with a totally different objective. His knowledge and understanding are not ends in themselves but rather a means whereby his ability to produce designs for useful systems and processes may be enhanced. A constructive way to approach this concept of engineering science is by an examination of the implications of current accomplishments in engineering.

At one time, for example, the elements of kinematics and descriptive geometry dominated the basic core of knowledge for the mechanical engineer who was likely to become deeply involved in the design of linkages, gears, and other mechanisms. These subjects remain in our engineering curriculums, but so much experience has been accumulated that standardized designs are readily available. The modes of analysis of mechanisms have become so much more efficient that methods formerly requiring a very high degree of understanding are now introduced and used at an elementary level. In 1863, Josiah Willard Gibbs, recognized as one of the outstanding scientists of the world, received the first doctor's degree awarded in engineering in this country. His doctor's dissertation covered an aspect of the design of gears—a subject which today would be included in the most elementary handbook on machine design.

Application of Science

Fluid mechanics is a field which the scientists first investigated many years ago. However, until fairly recently the theories were largely ignored by the engineer who found them incapable of handling the practical problems with which he was confronted. However, today these theories have been extended and perfected so that such phenomena as boundary layers, compressible flow, shock waves, and cavitation are encompassed so fully that they have largely superseded the older, empirical rules of the engineer. The successes that have made the aircraft industry possible, that have introduced the gas turbine into practice in so short a time, were based on an intensive use of the scientific method by the engineer.

Thermodynamics or, as formerly called, heat power, among mechanical engineers was primarily a collection of rules co-ordinated by one or sometimes two laws of thermodynamics, providing methods of analysis of a certain limited set of heat-power systems. In recent years with the impact of the gas turbine, rocket propulsion, solar and nuclear energy, refrigeration at near absolute zero, and information theory, among other developments, it can no longer suffice to associate thermodynamics solely with fully developed systems and materials. It is essential that the engineering student learn how to apply all the basic principles of thermodynamics, not just one—that he appreciate that magnetic and electric work may be just as important in fluid motion as is fluid displacement—that he recognize that there are many, many more thermodynamic media than steam and air. In short, here is a science of powerful breadth, yet one which may be applied immediately to the most practical of engineering problems. The principles must be set forth in broad generality so that the engineer may use them fully as basic tools in his new designs.

The field of materials is probably having as significant an impact as any of the engineering sciences. Within ten years we have seen the transistor develop from a laboratory experiment of the physicist to an every-day item in radio and television. The principles of solid-state physics that made this advance in electrical engineering possible are equally applicable to problems in the plastic deformation of solids, to the mechanics of metal forming and cutting, and to the phenomena of friction and wear. In addition, the metallurgist is developing new materials with an almost tailor-made ability to meet specifications. The mechanical engineer must not only be able to use materials with all the flexibility of choice available, but he must also understand the principles underlying the behavior of materials under various conditions of use such as stress, temperature, and radiation.

The emphasis in engineering training cannot afford to be rigid or circumscribed. The changes in the recent past, introducing new areas of science into engineering practice, will be followed by equally significant changes in the future.

New Domains

The task of introducing these new domains of science into the routines of engineering has become a major obligation of the research engineer. While the scientist probes further into the structure of an atomic nucleus, someone must come along and organize the principles which have been set forth so that useful methods of applying these to engineering can be available. This involves quite fundamental studies which have many appearances of pure scientific investigation. Yet the objective of research in engineering science is not to seek fundamental principles as such, but rather to obtain systematic procedures whereby engineering designs may be created readily and efficiently.

The field of combustion is a case where the engineering design methods at present are—aside from a few results from thermodynamics, heat transfer, chemical kinetics, and gas dynamics—largely a collection of empirical rules. There are many successful procedures, but there is a deficiency in basic principles on which to build substantially new designs. The intensive efforts of scientific studies in this field are certain to lead to much better design methods. In this case the usable findings of the scientist will be translated into engineering practice almost immediately—the need is so urgent.

The translation of research findings into engineering practice by the engineering scientists is a major function of certain of the professional divisions of ASME. This is particularly evident in the publications of the Applied Mechanics, Heat Transfer, and Gas Turbine Power Divisions. A further reduction of this information for incorporation into the basic training of all engineers is a constant need. To the extent that this is done, engineering science as the core of engineering training will not remain static in content or technique.

[3] Condensed from "Engineering Science, The Core of Engineering Training," by N. A. Hall, Mem. ASME, Department of Mechanical Engineering, Yale University, New Haven, Conn.

By D. L. E. Jacobs, Assoc. Mem. ASME, and I. H. Landes

Engineering Planning and Development, General Electric Company, Schenectady, N. Y.

EQUIPMENT for the Stationary Gas Turbine

The land gas turbine offers the simplicity of a self-contained prime mover. But accessories must be wisely incorporated to insure optimum system performance.

SINCE the first installation of commercial land gas turbines in 1949, American manufacturers have sold over 250 gas turbines for commercial service. These machines have ranged in size from 1200 kw to 21,800 kw (standard rating at 80 F 1000-ft altitude). Thus the land gas turbine has emerged from the experimental and pioneering stages and has taken its place alongside the steam turbine as a reliable, economic prime mover.

The simplicity of the gas-turbine installation is apparent when it is recognized that this is a self-contained prime mover which does not require the boiler, condenser, pumps, and many other equipments which are part of the steam-turbine cycle. In spite of the comparative simplicity of this prime mover, good design is necessary in those items, external to the turbine itself, which are incorporated into the gas-turbine installation.

Inlet-Air Ducts

First, the problem of getting the air into the compressor: Air requirements range from 349,000 lb per hr (approximately 82,000 scfm) for a 5300-kw unit to 1,370,000 lb per hr (approximately 322,000 scfm) for a 21,800-kw unit. It is usually not practical to draw air from the turbine room since the room would be essentially at ambient temperature whenever the turbine was operating. Therefore air should be ducted in from the outdoors.

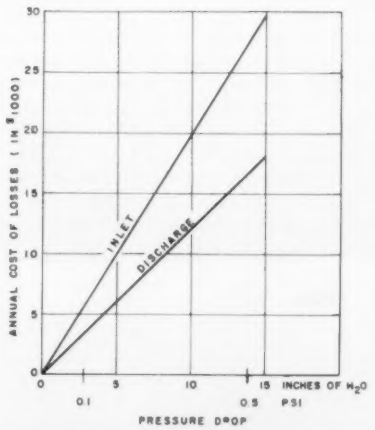
The air entering the compressor must be clean to avoid erosion or deposition, either of which will reduce compressor efficiency and increase maintenance. Since a reduction of one per cent in compressor efficiency will reduce net turbine output and efficiency by approximately two per cent, it is important that compressor efficiency be maintained at a high level. Most of the gas turbines installed in this country to date have been equipped with inlet-air filters.

Thus compressor-inlet air should be drawn from the outdoors through a filter and ductwork to the inlet hood of the unit. It would be tempting to save money on ductwork and perhaps on the filter by operating with very high air velocities, taking a pressure drop of 10 to 15 in. of water between the atmosphere and the inlet hood. However, filters should be selected and ducts designed with a full understanding of the effect of pressure drop.

Inlet pressure drop has the effect of causing lower output and efficiency by reducing the air flow through the machine and reducing the pressure ratio across the turbine. In the first case, inlet pressure drop reduces the density of the air entering the compressor. This reduction in density decreases the mass flow of air since at a given speed the compressor operates with essentially a constant-volume flow. The second condition occurs because the compressor operates at almost constant pressure ratio. With inlet pressure reduced, the compressor-discharge pressure also drops. The decreased pressure ratio now available to the turbine thus results in reduced turbine output.

In many cases, the capacity lost due to pressure drop must be replaced either by additional installed capacity or purchased power. Typical costs of replacing the lost capacity are shown in Fig. 1.

Fig. 1 Capacity lost due to pressure drop in the inlet ducting must be replaced either by additional capacity or purchased power. This graph shows the cost of replacing lost capacity for a typical 5300-kw turbine generating station, with fuel valued at 20¢ per million Btu, annual load factor of 60 per cent, and 20 per cent fixed charges (installed cost $200 per kw).



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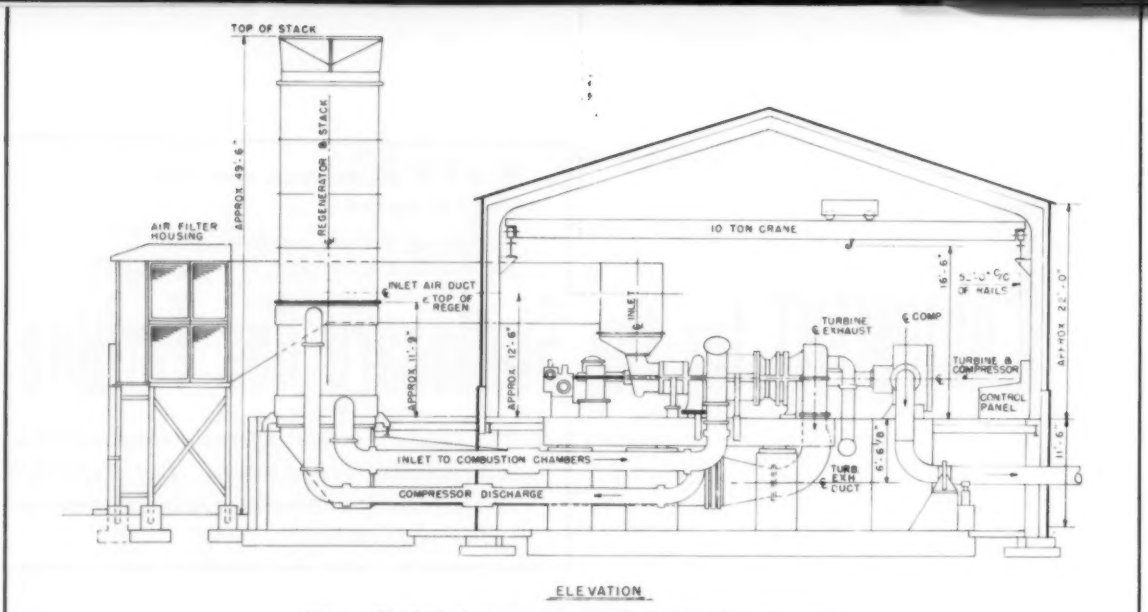


Fig. 2 Typical plant arrangement for a 7600-hp regenerative-cycle plant driving centrifugal compressors. The filter house can be seen at the left.

Discharge Ducts and Stacks

In discharging hot gas from turbine to atmosphere, pressure drop is again of importance, though the effect is not so great as on the inlet side. The air flow through the cycle is not affected by increases in turbine discharge pressure drop. Increased turbine discharge-pressure drop does, however, decrease turbine output with constant fuel consumption.

In general, sizing of discharge ducts will not be a problem with regenerative gas turbines since the turbine manufacturer normally provides all the ductwork connecting the turbine and the regenerator. In the past the regenerator has been located outdoors and the stack mounted directly on top. However, the problem of sizing the stack still must be solved. In addition to this, the design must avoid excessive recirculation of discharge gas into the compressor inlet. When recirculation occurs, the temperature of air entering the compressor is increased. This results in decreased capability and lower cycle thermal efficiency.

Recirculation can be reduced by increasing the gas velocities leaving the stack, by increasing stack height and, if there is a prevailing wind direction, by placing the stack downwind from the inlet. The first two of these alternates tend to result in greater discharge pressure drops; the latter, of course, is merely taking advantage of a natural phenomenon. The design objective is to strike a compromise by insuring against recirculation, yet maintaining a minimum pressure drop.

Duct Systems

To minimize the possibility of vibration or pulsation, the inlet and exhaust ducts should not be hung from the building structure but should be supported from the floor. The duct should be designed with sufficient structural stiffness so that the air flow itself will not cause excessive vibration. Duct supports must also be designed so that the resultant vertical load and resultant moment or couple applied to the compressor flange and the turbine flange do not exceed the limits specified by the manufacturer.

Expansion joints are required in both inlet and exhaust ducts because the gas turbine, when in operation, will expand due to changes in temperature. There is also a large amount of expansion in the exhaust duct.

Design of the intake duct is normally very straightforward. The designer is concerned primarily with passing the required amount of air with a minimum amount of pressure drop. The routing of this duct will of course depend mainly on the physical layout of the plant, taking into consideration such things as location of compressor-inlet flange, size and configuration of the inlet silencer, length of run and number of bends for alternate routings, amount of interference with service facilities such as cranes, and preferred location for the inlet filter.

Inlet ducts are normally fabricated from $^{3}/_{16}$-in. steel or Transite. To prevent drumming and to reduce noise level, heavier material, usually $^{3}/_{8}$-in. steel, should be considered for all elbows and any straight section downstream from the silencer. The silencer, and all sections of duct downstream from it, should have acoustical insulation. Turning vanes should be provided in the elbows to keep pressure losses to a minimum. A manhole will provide a convenient means for cleaning and inspecting the inlet duct.

Expansion joints and gaskets are usually made from synthetic rubber. The expansion joint should be placed upstream of the silencer when possible because this type of joint is difficult to insulate for noise.

The discharge duct presents a slightly different problem. In this case pressure drop is not so critical, but the temperature of the gas presents some unique problems. Special consideration must be given to expansion and insulation. Exhaust-gas temperature is approximately 840 F for a simple-cycle machine and 600 F for a regenerative machine. On a 50-ft duct, total expansion of as much as three in. may be encountered. This expansion requires special spring mounting for the duct to insure "in-line" movement at the expansion joint.

The discharge duct is usually fabricated from sheet steel. The expansion joint can be made of glass cloth backed with rock wool when there is no back pressure or

when leakage is not objectionable. Metal joints are normally used on regenerative machines and on simple-cycle machines when a heat-recovery boiler is used. Three-and-one-half inches of rock wool with $^1/_2$-in. plaster outer coat will normally provide adequate insulation on the straight portion of the discharge duct.

Inlet Filtering

The two basic types of filters that have been applied in gas-turbine installations are:

Viscous type—filtration through viscous-coated filter panels.

Dry type—filtration through glass fiber pads.

The viscous-type air filter can be an automatic, self-cleaning filter that is cleaned and recharged by passing it through an oil reservoir. One type is constructed in the form of an endless curtain of overlapping filter panels, driven by a fractional-hp motor. The oil bath removes foreign material that has been collected by the filter and prepares the curtain for further filtering action. Operation of the drive motor is intermittent, controlled by an electric timer. For abnormal inlet conditions a "timer bypass" allows the filter to move continuously.

Maintenance is limited to the removal of sludge from the cleaning tank and replacement of oil in the reservoir. For the range of gas turbines now available, 5300 to 27,500 kw, a stock of 20 to 60 gallons of oil a year should be sufficient to replace oil taken off with the sludge.

Dry-type filters are available in square-pad form for fixed-filter installation and in long-roll form for automatic operation. For fixed-filter installations small individual filter cells made of oil-impregnated cellulose paper are installed in a field-erected prefabricated housing made from steel or Transite. The housing can be mounted on a foundation or erected on columns, with weather louvers for air intake. To service the cells each pad must be removed, the old filter media removed and replaced.

The automatic dry-type filter is a long glass-fiber blanket rolled on a spool. During operation the filter is fed from the supply spool to a discard spool after having accumulated dirt load. The rate at which the timing device drives the blanket requires a replacement of the filter roll about every four months with normal dirt loading and atmospheric conditions. An override on the timer measuring pressure drop across the filter permits satisfactory automatic operation during abnormal weather.

Filter sizes should be selected for approximately 400-fpm face velocity. Pressure drop through the filter equipment with this velocity is 0.5 to 0.75 in. of water. Cleaning efficiency for the dry-type filter is about 85 per cent, and about 92 per cent for the viscous type.

The approximate cost of filter equipment including the filter, controls and drive, weather louvers, and miscellaneous hardware is tabulated below. This cost information is for the filter sizes between 80,000 and 320,000 cfm.

Type	Estimated Cost[a]
Viscous	$110/1000 cfm (approx. 4300 lb/hr)
Dry, automatic roll	$90/1000 cfm
Dry, fixed pad[a]	$165/1000 cfm

[a] NOTE: This cost includes the complete housing with filter cells, knocked-down construction for field erection on customer's supports.

Housings for automatic filters are normally of the same type as those described for the fixed-filter-pad installation. A typical filter house is shown in Fig. 2. All seams and joints on the clean side of the filter should be made airtight, and access doors should be provided at both the front and rear of the filter for maintenance. Positioning of the weather louvers and design of the inlet section to the filters should insure good operation despite blowing snow and other severe weather conditions. If the application requires operation of the filter at subzero temperatures, special considerations are necessary.

Silencers

The problem of inlet and exhaust silencing for gas turbines increases as ratings increase. Standard silencer

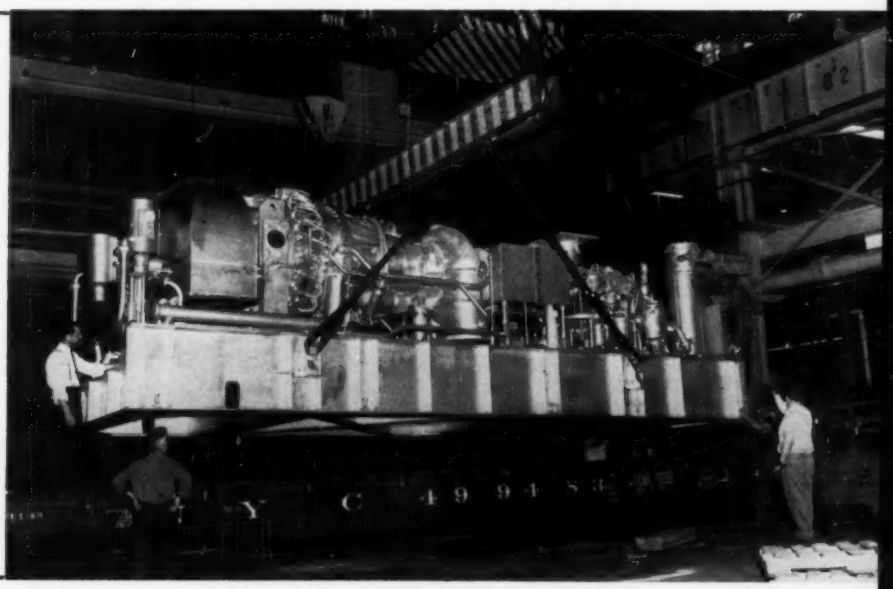


Fig. 3 Turbine units rated at 10,000 kw and below are mounted on fabricated bases, complete with all piping and interconnections, for shipping and installation. This is a 6700-hp regenerative-cycle unit.

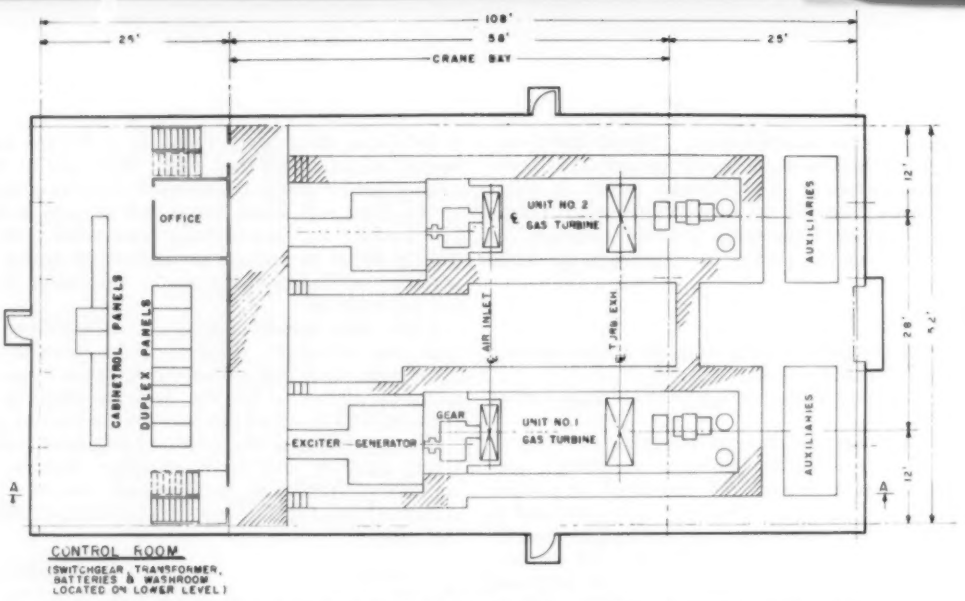


Fig. 4 Plan view, installation of two 10,000-kw simple-cycle units. Here, each unit is mounted on a slab foundation, with all ducting overhead. To reduce crane and building height, the inlet silencer can be located in the horizontal section of the duct.

designs are available for the smaller-size units, but for machines 15,000 kw and above, it is important to engineer each application because of available space, pressure drop, and noise-level requirements.

The divergence of inlet and exhaust noise approximates a hemisphere around the turbine. This front, however, can vary considerably with the location of the inlet and exhaust, the duct construction, and natural barriers. Inside the station, near the gas-turbine unit, the noise level will be approximately 95–100 db (decibels). This level is approximately that experienced inside a boiler plant. With proper inlet and exhaust silencing and good architectural design, sound levels measured at distances of 400–500 ft from the station are reduced to that of traffic noise.

Consideration must be given to the acoustical characteristics of the building. Proper structural design with acoustic material in the walls can do much to obtain the desired sound levels, both inside the building and in the surrounding areas. For instance, a station with glazed tile walls and polished concrete floors could maintain substantially the same noise level throughout the building. The entire station could form a good resonant sounding board transmitting noise to the nearby area.

Theoretically, the best location for silencers is as close as possible to the inlet and exhaust of the turbine. In many installations this is practical for the inlet silencer, but because of the size of the exhaust silencer, it normally must be located in the base of the stack outside the building. Studies of the pressure-drop effects on the gas turbine due to inlet silencing indicate that 1 to 3 in. of water will normally provide satisfactory performance; normal exhaust-silencer pressure drop is approximately 2 in. of water.

Inlet silencers are usually rectangular in cross section, to match the inlet duct. Experience indicates satisfactory performance when air velocities through the silencer section do not exceed 75 fps. The silencer consists of a number of acoustic baffles of sound-absorbing material. Mechanical design is important because failure of any part could cause serious damage to the gas-turbine compressor.

Exhaust silencers are circular in construction with straight-through flow past an "X" constructed of acoustic panels. The fibrous material of the panel is enclosed in perforated steel to prevent its being blown out the stack by the 200-fps exhaust gases. Exhaust silencers are usually not applied on gas turbines utilizing a regenerative-cycle or heat-recovery boiler because these equipments act as satisfactory silencers in themselves.

The cost of silencers is primarily a function of the volume flow. Approximate costs of silencers for a 16,500-kw unit would be: inlet, $12,000; exhaust, $30,000.

Each installation has its individual silencing problems. Good control of sound levels is a function of more than the silencer design itself, and it is essential that all variables of the problem be taken into account in order to obtain satisfactory performance.

Plant Arrangements

Fig. 2 shows one gas-turbine-plant arrangement. Units may be mounted on slab foundations with all ducting overhead. To reduce crane and building height, the inlet silencer may be located in the horizontal section of the duct. Fig. 3 shows a turbine, complete with piping and connections, ready for shipping.

A plan view for a typical plant having two 10,000-kw simple-cycle units is shown in Fig. 4. Two 7600-hp units in an actual installation are shown in Fig. 5. The regenerator and all the ducts between it and the turbine are usually furnished by the turbine manufacturer.

Control Equipment

The turbine control panel is supplied with the gas-turbine unit. A typical gas-turbine control panel applied to an industrial application is shown in Fig. 6.

All other control equipment is supplied by the purchaser. This would probably include:

A-c and d-c starting equipment and the distribution panel boards for both the turbine and the station auxiliaries.

Control and instrumentation for the generator and exciter in a generating station.

High-voltage switchgear.

Process control for mechanical-drive gas-turbine applications.

For neat appearance this station control is normally located in panel equipment similar to the gas-turbine control panel. The control can be mounted in tunnel-type Duplex switchboards (access door in tunnel between panels) with instruments, recorders, and control on front panels and protective relays on rear panels, or in panels with all instrumentation on the front side. For possible locations of control-panel equipment, refer to Figs. 2 and 4 showing typical gas-turbine-station layouts.

The control system in modern gas turbines is inherently semiautomatic and self-regulating. It can be made completely automatic. Automatic control eliminates much of the routine and responsibility for personnel in operating the unit, a single main hand-control device being the master control switch which initiates the sequence for automatic start and stop.

Starting Power

Since a gas turbine cannot sustain itself until sufficient combustion air is supplied, cranking power is required to operate the unit at 15 to 20 per cent speed. This will require 2 to 5 per cent of the rated output of the unit. If the gas turbine is driving a compressor or pump which cannot be completely unloaded, the starting device must be adequate to supply this additional load.

Where a starting motor is used, it is necessary to insure that the electrical system is adequate for the starting kva of the motor. The manufacturer normally supplies a wound-rotor motor, having 250 to 300 per cent starting inrush current, complete with controls and automatic disengaging clutch.

A small steam turbine, gas-expander turbine, or internal-combustion engine may be used for cranking. In plants where steam is available, a steam turbine may be used, or in the case of a pipeline pumping station a gas-expander turbine is often applied, such as shown in Fig. 5.

Water Requirements

The gas-turbine parts are cooled primarily by air obtained from the last stages of the compressor. Only a small amount of water is required for cooling the lubricating oil and for the air or hydrogen coolers on the generator. With 95 F water, approximately 500 to 800 gpm are required, depending on the rating of the turbine-generator set. For mechanical-drive applications, cooling-water requirements for the gas turbine alone are less than half the foregoing totals.

Evaporative Cooling

By cooling the inlet air artificially, output capability and efficiency can be improved. An evaporative cooler (air washer) cools air by evaporating water in direct contact with it. The cooler spray nozzles are normally located behind a viscous or dry-type air filter. In one type of cooler the water is sprayed on tilted pads that form the evaporating surface; mist extractor pads at the rear of the cooler prevent water carry-over. Practical humidifying efficiency of commercially available evaporative coolers is 70 to 80 per cent. For inlet conditions of 95 F dry bulb, 40 per cent relative humidity (75 F wet bulb), and 70 per cent humidifying efficiency, the outlet air temperature from the cooler would be about 81 F (70 per cent of the difference between 95 F and 75 F).

This decreased inlet temperature to the gas turbine, 95 F to 81 F, yields an increase in output of seven per cent. For a 9500-kw unit (80 F 1000-ft altitude rating) this would be an increased output of approximately 670 kw. The gain in output is obtained with increased investment only in the filter equipment itself, which may be $18 to $20 per kw for the increased capability.

Pressure drop through the evaporative cooler is about 0.4 in. of water. Make-up water for the air washer

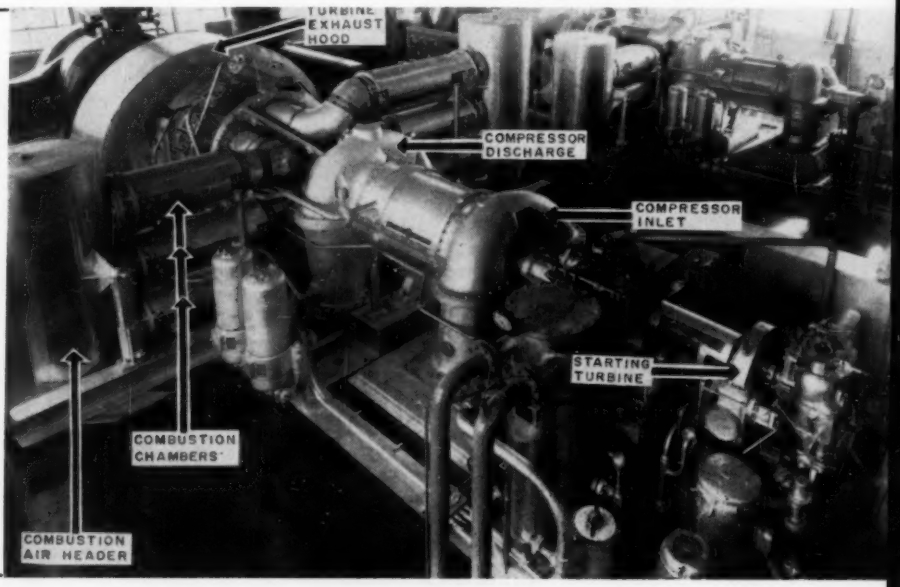


Fig. 5 Two GE 7600-hp regenerative-cycle two-shaft units in a gas-pumping station. The duct connections to the turbine compressor and the combustion chambers can be seen. All ducts are run under the floor. The manufacturer can usually supply the compressor inlet casing and the turbine exhaust hood, designed for entry from either above or below, as required for best station arrangement.

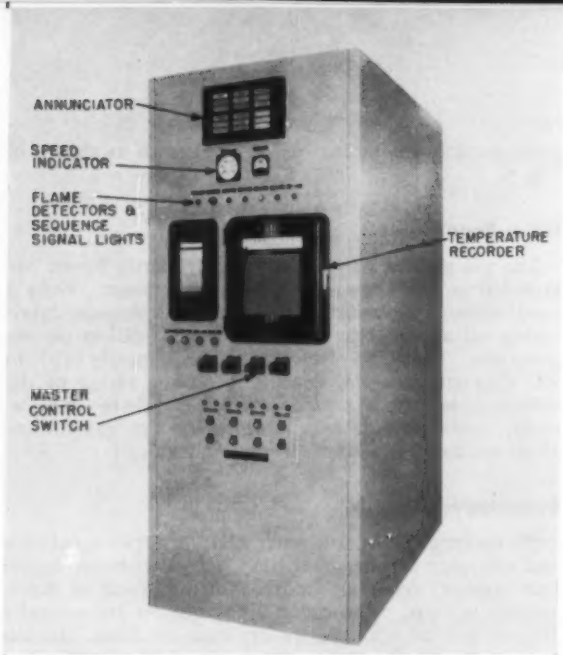


Fig. 6 A turbine control panel supplied with the turbine. It includes starting and supervisory control, such as master control switch for starting and stopping, speed-setting switch, speed indicator, protective relays for the turbine, flame-detector relays, and annunciator alarms. All other control equipment is supplied by the purchaser.

ranges from 3 to 10 gpm for the range of gas-turbine sizes and normal ambient conditions.

To protect the gas turbine against possible water carry-over, the evaporative cooler should be located about 40 to 50 ft from the unit, with provisions in the bottom of the duct for drainage. Fig. 7 shows a typical structure for an air washer installed at a pipeline pumping station.

Fuels

The gas turbine can burn natural gas, distillate oil, and, when properly treated, the heavier residual oils (Bunker C).

If gas is not available at a pressure of 150 psig, or if at any time the pressure may fall below this level, a fuel-gas-booster compressor must be installed to maintain this pressure, which is required for satisfactory fuel injection into the combustion chambers.

Storage and day tanks, transfer pumps, and the necessary piping must be provided if oil is to be burned in addition to, or instead of, natural gas. Storage tanks are usually selected to provide at least two weeks' supply.

Dual Fuel Operation. With certain modifications the gas turbine can be designed to use either gaseous or liquid fuels—natural gas to distillate oil, or natural gas to residual oil. This feature is available at additional cost over the basic unit. Fuel transfer is made while running under load, burning both fuels during the changeover period. Transfer systems are available for both manual transfer at the unit or automatic transfer at the control panel.

The dual fuel system to utilize both gas and oil is equipped with parallel fuel systems from the customer's connections to the fuel nozzles, the nozzles being designed to operate with both.

Mechanical atomizing fuel nozzles are supplied for a gas-distillate oil unit and air-atomizing fuel nozzles, with their associated equipment, for gas-residual oil. The mechanical atomization system is primarily for use where only emergency or short-time operation on distillate oil is required. For prolonged operation on distillate oil the air-atomization system should be used.

The components of the dual fuel system are included in the accessory section with mounting at the forward end of the machine. This equipment takes very little additional space over the conventional accessories. Fig. 8 shows the accessory end of turbine with the dual system.

Residual-Fuel Treating. Normal residual oils contain elements such as sodium and vanadium which have highly undesirable effects on high-temperature machine parts when burned in a gas turbine. Sodium causes metal corrosion and builds up hard deposits which choke the gas passages; vanadium is highly corrosive to hot machine parts. Calcium also causes hard deposits.

When residual fuel oil is burned, it is necessary to use a fuel-treating system to reduce the quantity, or inhibit

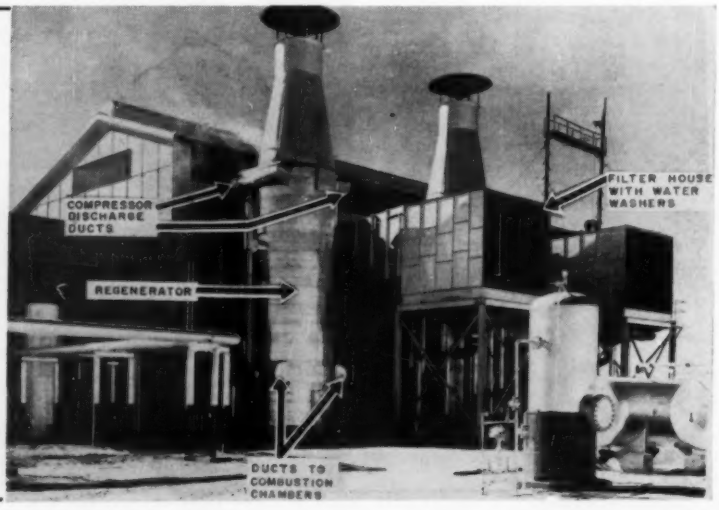


Fig. 7 A gas-turbine pumping station, showing regenerators and air washer. Note the weather louvers on the inlet to the washer, and the sloping duct behind the washer to prevent possible liquid carry-over into the gas-turbine inlet. There is provision for drainage at the bottom of the duct.

the action, of these unwanted elements to such an extent that they cause no serious problem in the turbine. To accomplish this, the fuel oil must have the following characteristics after being treated.

1 Sodium content in ash must be no greater than 30 per cent of vanadium content. Maximum sodium content 10 parts per million (ppm), 5 ppm preferable. With less than 5 ppm sodium, ratio of sodium to vanadium is not critical.

2 Magnesium content in ash must be at least three times that of vanadium. With vanadium less than 2 ppm, this requirement is not critical.

3 Calcium content should be 10 ppm or lower. However, up to 20 ppm can be tolerated at the expense of an increased rate of turbine-nozzle plugging.

4 Lead content should not exceed 5 ppm. It has the effect of nullifying the inhibiting action of magnesium on vanadium.

The basic system recommended by the General Electric Company to treat residual oil, first heats the oil and then leads it to a mixer in which the raw fuel oil is mixed with about 5 per cent of water. The oil-water mixture is fed to two centrifuges in series where the water is separated from the fuel taking with it most of the sodium which was originally carried in the oil. The washed fuel is piped to a clean-oil storage tank where it is stored prior to burning in the gas turbine.

In the washing phase the amount of calcium originally contained in the fuel is also substantially reduced.

If the oil is a naturally heavy fuel, its gravity may be too close to that of the wash water to make good separation in the centrifuges practical. When such a heavy oil is encountered, it is necessary to increase the gravity of the wash water by adding a salt solution to it, such as magnesium sulfate.

Since vanadium is unaffected by the washing operation, an inhibitor must be added to the oil to overcome the corrosive tendency of this element. Magnesium is used in the form of a water solution of magnesium sulfate ($MgSO_4 \cdot 7H_2O$), more commonly known as Epsom salts.

This solution is intimately mixed with the washed fuel oil and is then fed to the gas-turbine combustion system. Because of the tendency of the water solution to settle out of the oil, the inhibited fuel must be burned immediately after the magnesium-sulfate solution has been mixed into the stream.

The installed cost for the oil-treating and associated equipment will be in the order of $135,000 to $200,000 for gas turbines covering the range of 5300 kw to 21,800 kw.

This cost includes equipment for water washing, centrifuging, and injecting additives, as well as small heating boilers and heat exchangers required to heat the oil, transfer pumps and piping, distillate-oil tanks for starting, day tanks, and residual-oil storage tanks having capacity for two weeks' operation. Approximately 1000 sq ft of floor space is required for the oil-treating equipment, excluding the oil tanks.

At present, the cost of oil treatment is approximately 14¢ per bbl (about 0.3¢ per gal), and an excellently cleaned oil is obtained. It is possible that with further development the cost of treatment might be substantially reduced.

The foregoing specifications for the treated residual oil also apply to distillate fuels. But most distillate oils will meet the requirements without treatment.

Distillate Oil for Start and Stop of Residual-Fuel-Burning Machines. Residual oil will solidify and plug up the fuel lines and nozzles if allowed to remain in the lines during a shutdown. To prevent this, distillate oil is used for 5 to 10 min prior to shutdown, to flush all residual oil from the fuel lines.

Distillate oil is also used during start-up because it is easier to ignite than residual oil. Transfer to residual oil is made when the unit is up to rated speed.

Summary

Although the gas turbine is a recognized prime mover for generator and mechanical-drive applications in industrial, electric-utility, and transportation fields, the concepts of station design have not been as yet fully standardized. This report has enumerated some of the factors which should be considered, to integrate the gas turbine into a power plant. A thorough understanding of these and other factors is essential to obtain the optimum system efficiency and reliability.

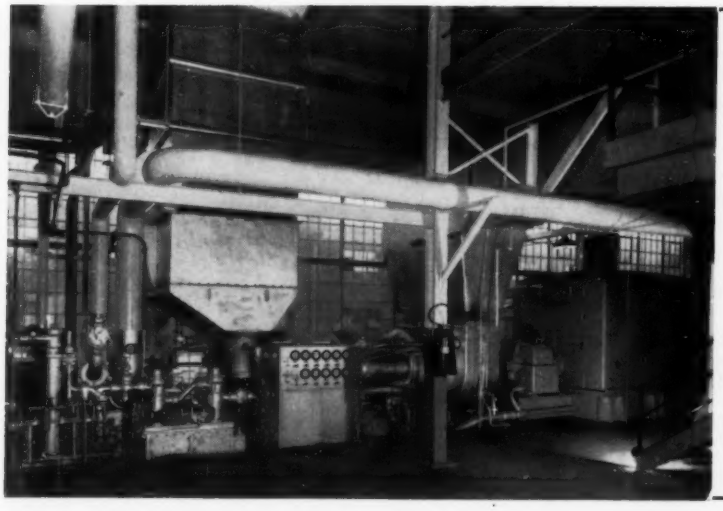
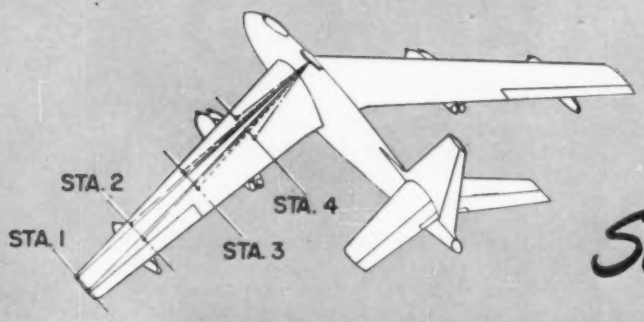


Fig. 8 The dual fuel system (gas and distillate oil) installed at an industrial plant. The system is part of the accessory section, mounted at the forward end of the machine. Pressure gages and stop valves for both fuel systems are included in the instrument-and-gage board alongside the turbine.



By Clifford H. Nelson, NACA Langley Aeronautical Laboratory, Langley Field, Virginia

Selecting Flight Test INSTRUMENTATION

Five systems used at the Langley Aeronautical Laboratory serve special purposes and provide

THE selection of instrumentation to fill the needs of an active flight-research group requires the availability of a broad range of measuring systems and data-processing equipment. No one single system can handle the measuring task, and each system has particular areas of application where its use is clearly indicated.

All flight-test instrumentation systems have in common the use of sensing and recording elements. Every system requires sensing elements or transducers to convert the function being measured such as pressure, temperature, angular position, and the like, into some proportional variation of output signal that will activate a recording medium or visual display. As there is an almost endless variety of combinations of pickups and signal-transfer links to the recorders, the discussion will be mainly confined to five instrument systems in use at the Langley Aeronautical Laboratory of the National Advisory Committee for Aeronautics listed in Table 1.

Photographic Recording

Cameras are used in flight testing for many different purposes. They are especially useful for documentary purposes and for recording motions or position changes. Examples include the study of air-flow direction changes over various parts of the airplane by means of tuft surveys, and target-tracking programs where the camera is used to record a view of the gun sight and target identical to that seen by the pilot.

Photo-panel recording of instruments, such as the airspeed, altitude, and tachometer indicators, is another use of photography. The major disadvantages of photo-panel recording are the low-frequency response of the commonly available indicating instruments, the lack of continuous data, and the time required for data reduction.

Two other specialized applications of photographic recording have been made by our Langley instrument group. The first was the design of an optical recording system to study the effects of flexibility on the performance of a large bomber-type aircraft with a continuous-trace-type recorder.

The optical recorder or optigraph, as it is generally called, was designed to measure the wing, tail, and fuselage deflections. The left part of Fig. 1 illustrates the basic principle. Light from the target lamps passes through a lens, then through two slits in a mask, and onto a moving photographic film. The trace deflections are thus proportional to the target-lamp deflections. Vertical trace movements correspond to bending, and the relative-amplitude differences represent twist. Target lights were mounted in chordwise pairs at four stations approximately 16 ft apart along the span of the wing. Eight other targets were placed on the right wing and vertical tail assembly and recorded on a similar unit. The full-scale deflection of the wing tip was approximately 3 ft and the resolution of the recorder was such that the wing-tip motions of $^1/_4$ in. at a distance of 60 ft corresponded to record-trace deflections of 0.003 in. The optigraph was mounted rigidly to the structure joining the wing and fuselage assemblies. Infrared film, Wratten 87 filters, and 100-watt concentrated-filament target lamps eliminate blue-sky background and fogging.

The second example of photographic recording was reduction of data work-up time in connection with pressure-distribution studies of airfoil sections during flight, Fig. 2. An outline of the section-pressure dia-

Table 1 Instrumentation Systems

1 Photographic recording
2 NACA mechanical-optical recorders
3 Senser outputs into oscillographs
4 Senser outputs into magnetic tape
5 Senser outputs into radio telemeter

Table 2 NACA Mechanical Optical Recorders

Type recorder	Number of channels	Hysteresis and friction, per cent of F.S.	Reading accuracy, per cent of F.S.	Temp effect, 0–100 F, per cent of F.S.	Natural frequency, cps
Airspeed altitude	2	1/4	1/15	1/4	Lag of tubing
Linear acceleration	3	1/4	1/8	1/2	10 to 30
Angular velocity and acceleration	2	1/2	1/4	1/2	10 to 20
Gyro attitude	1	—	(0.05 deg)	—	—
Flow angle	2	(0.1 deg)	(0.05 deg)	—	Syncro 8
Tachometer	1	1/10	1/10	1/10	—
Manometer	24	1/4	1	2	Lag of tubing

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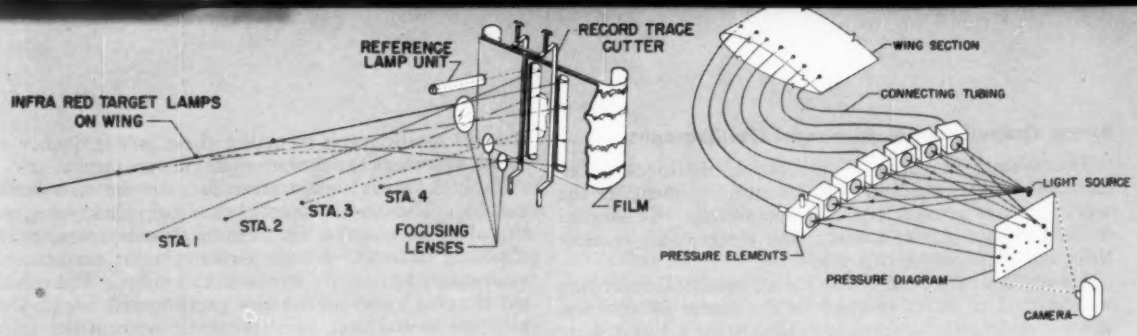


Fig. 1 Flight optigraph. Light from the target lamps on wing (*shown left*) passes through a lens and slits onto a photographic film. Trace deflections are thus proportional to the wing deflections.

Fig. 2 Pressure diagram manometer. An outline of the airfoil-section pressure diagram is continuously produced by spots of light on a ground-glass screen which can be photographed by a movie camera.

an increasingly comprehensive and readily available evaluotion of performance in flight

gram is continuously produced by spots of light on a ground-glass screen, which can be photographed with a movie camera. Small pressure elements move the light spots in accordance with the orifice pressures. All 30 of the pressure elements are linear and of equal sensitivity to avoid errors and distortion in the resulting diagram. Pictures are taken of the screen at 128 frames per sec.

The frequency response of this pressure-diagram recorder is governed by the acoustical lag associated with the length of the connecting tubing.

NACA Mechanical-Optical Recorders

During the period prior to World War II, the NACA had developed a complete line of mechanical-optical recording instruments specifically designed for airborne use. The recording system was designed so that each recorder should be a separate unit, be relatively immune to the environment of flight, and be accurate and reliable.

These recorders convert the phenomena being measured to proportional small mechanical displacements, and by means of an optical amplifier provide continuous time-history records on film. The separate film drums are run at equal speeds by 400-cycle synchronous motors driving the precision film-metering rollers. Two widths of film are used; namely, $2^{7}/_{16}$ and $6^{1}/_{2}$ in. The magazines have a capacity of up to 75 ft of film. Vertical timing marks are applied simultaneously to all records by a central timer which supplies coded electrical pulses to facilitate time correlation. Recording film is used rather than paper because of its dimensional stability.

Table 2 lists some characteristics of the recorders comprising the mechanical-optical system. The number of data channels shown is exclusive of timing and zero reference lines. The accuracy figures relating to hysteresis and friction, reading accuracy, and temperature effect are given in per cent of full scale with the exception of the gyro-attitude and flow-angle recorders. In these two cases, the angular errors have more significance than the per cent errors as the full scale of the attitude gyro is 360 deg and flow recorder has a range of ±45 deg. The accuracy figures relate to the recorders only, and do not include installation errors. Linearity is not included as calibration curves are normally used. The natural-frequency figures include the minimum and maximum values that correspond to setups for different full-scale ranges.

The natural frequency of these recorders is such that the response is adequate for recording airplane maneuvering frequencies, and yet low enough to attenuate undesirable extraneous inputs, such as structural vibration, and also to effectively filter them out of the record.

Most of these instruments record several channels. The 24-channel manometer is an outstanding example of compact design. In the case of both the airspeed-altitude and flow-angle recorders, errors of the airstream-sensing head are not included. For the gyro-attitude recorder, which employs a cageable free gyro as its basic measuring element, the accuracy figure applies only to the measurement of changes in attitude during relatively short low-amplitude maneuvers.

Airspeed-altitude recorder. The airspeed-altitude recorder normally has provision for measuring both static and impact pressure. Fig. 3 indicates the use of a corrugated capsule to convert the desired pressures to small mechanical deflections. A pivoted lever tilts the mirrors, causing the recording light beam to move across the film. Five mirrors are employed to obtain multiple sweeps of the film, yielding a total full-scale deflection of 10 in. Each mirror can be identified by noting the deflection of the index-record line. In cases where altitudes greater than 50,000 ft must be measured, as in the research aircraft at the NACA High Speed Flight Station at Edwards, Calif., nesting absolute-pressure capsules are employed to extend the range of measurement.

Angular velocity and acceleration recorder. A sketch of the combined angular-velocity and angular-acceleration recorder is shown in Fig. 4. The synchronous gyro motor is mounted in a pivoted gimbal that is restrained by precision springs. Magnetic damping is provided by means of a thin aluminum disk rotating in a magnetic field. Gimbal deflections which are proportional to the airplane's angular velocity are amplified by an optical system and recorded directly on the moving film. Angular acceleration is obtained by differentiating the motion of the angular-velocity gimbal. A small brushless d-c generator is used for this purpose and supplies sufficient voltage to drive a recording galvanometer. Full-scale ranges can be adjusted from 0.1 to 4 radians per sec.

The advantages of the mechanical-optical system can be summarized as: High accuracy primarily because of the use of the optical lever to convert the small sensing-element motions into amplified film deflections. Lever characteristics are independent of the variations of an external power supply and unaffected by the environment of flight. The instruments are stable and retain their original calibration over a long period of time with a minimum of maintenance. The recorders were designed with adequate frequency response to measure the primary flight parameters under maneuvering conditions.

Senser Outputs Into Multichannel Oscillographs

The system of using multichannel oscillographs to record the outputs from remote sensing elements is the work horse of aeronautical instrumentation. It consists of three major parts, namely, the senser, data-transfer link, and recording oscillograph.

Sensers are prime requisites for all electrical recording systems. The errors induced in the senser by environmental effects encountered in flight testing are extremely difficult to eliminate. The most important environmental factors are vibration and acceleration, pressure, temperature, and humidity. The decision to use a particular unit is generally influenced by the senser's response to these environmental factors.

Hundreds of different sensers are currently available. Various techniques convert the desired phenomena into a change such as resistance, inductance, or capacity.

Our goal has always been to achieve the highest accuracy consistent with reliability, long-term stability, and ease of system maintenance. The great bulk of our sensers or transducers are of the wire strain-gage type, with an output sufficient to drive oscillograph elements with natural frequencies up to 300 cps. The more complex amplifying equipment with its accompanying greater bulk, maintenance, and malfunctions is avoided.

The data-transfer link for wire-gage sensers consists of a control box with provision for zero and sensitivity adjustment as well as a semiautomatic means of providing a resistive-shunt type of in-flight calibrated signal.

When slowly changing senser signals from various sources such as control forces and displacements, temperatures, structural strains, accelerations, and pressures are to be recorded, it is desirable to use low-frequency galvanometers. These should have natural frequencies of between 10 to 20 cps to obtain large attenuation of signal noise.

To fulfill this need for an oscillograph with a moderate range of natural frequency, the Langley Laboratory initiated the development of a D'Arsonval type of recording galvanometer in conjunction with the Weston Instrument Company. These galvanometer elements later provided the basis for a 12-element oscillograph. The small coil elements are suspended on 0.004-in-diam cylindrical pivots running in olive-holed jewels with end-stones, similar to those employed in watch design. This construction was necessary to achieve the required stability for use in the environment of flight. A mirror attached to the coil assembly permits a ±4-deg angular movement to correspond to ±1-in. film deflection.

Very recently low-frequency string-suspension galvanometers have become available commercially. The Langley instrument group has designed a compact 36-channel oscillograph to utilize these low-frequency elements as well as those of much higher frequency.

Table 3 shows comparative data on the two oscillographs. The new 36-channel oscillograph is superior to the older D'Arsonval recorder in all categories, and by choosing different recording elements the frequency response may be changed over a 30 to 1 range. The volume-per-channel figure on the new oscillograph is exceptionally low as only the basic essentials were in the design.

Our experience indicates that accuracies of the order of 1 to 2 per cent are the best that generally can be attained with this combined system of senser outputs into multichannel oscillographs. The system has several unique advantages. As the output of the transducers is electrical in nature, they can be combined in the aircraft to obtain a time-history record of a computed quantity, such as lift on a wing. In addition, where a survey of a large number of quasistatic data channels is required, the signals may be recorded on only a few oscillograph channels by the use of commutators or switches. This approach can lead to large reductions in the size of the recording equipment.

A review of the oscillograph recording system includes the following advantages: The system is capable of recording senser signals with frequency content above 100 cps without auxiliary amplification. The natural frequency of the recording element can be as low as 10 cps. Sensers are commercially available to convert practically all of the desired flight measurements into electrical signals. The system provides for centralized recording and is of small size and has good reliability.

The main disadvantage of the system is the lack of fast record read-up methods. A scheme for automatically reading oscillograph records at speeds many times faster than the present manual methods is needed.

Airborne Magnetic-Tape Recording

This relatively new system, of recording flight data on magnetic tape, has had a tremendous impact on the older established methods of data processing. Airborne tape systems have no size, accuracy, or complexity advantages over oscillographic recording. However, they can store data during flight which can be played back and processed automatically on the ground.

Table 3 Characteristics of Two Flight-Type Oscillographs

Type	Number of channels	Natural frequency, cps	Maximum sensitivity, μa/in.	Volume, cu ft
D'Arsonval	12	10–16	50	0.7
String-suspension	36	10–300	1.6	0.5

Fig. 3 Static pressure-recording element. A corrugated capsule converts desired pressures to small mechanical deflections. A pivoted lever tilts the five mirrors, causing the recording light beam to move across the film.

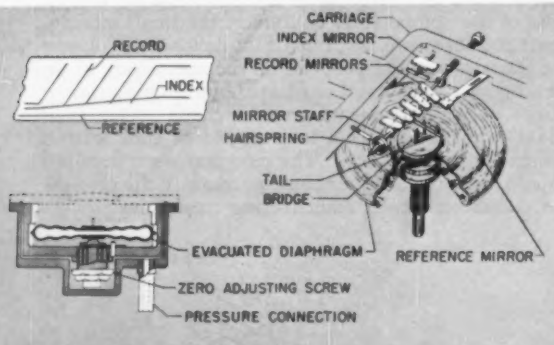
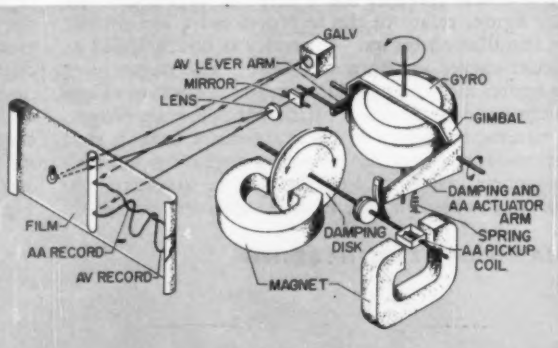


Fig. 4 Combined angular velocity and acceleration recorder. The synchronous gyro motor is mounted in a pivoted gimbal that is restrained by precision springs. Gimbal deflections are amplified by an optical system and recorded on film.



The application of magnetic-tape recording is ideally suited to two areas of research where data processing is of major concern: (*a*) In flight-test programs that require the measurement of hundreds of data channels as in pressure and temperature measurements that vary at a slow rate; (*b*) in the measurement of dynamic parameters as in flight tests concerning vibrations, gust loads, or buffeting where available frequency and power-spectral-analysis equipment may be used to reduce the data-processing work load.

The two principal ways of storing data on magnetic tape are by continuous recording or in separate samples. For high-frequency measurements or where frequency analysis or phase comparisons are to be made, the continuous-type record is required. The sample recording is most useful for handling many channels that may be commutated and recorded several times a second.

For continuous-recording methods, such as frequency modulation, the mechanical design of the tape-drive mechanism becomes of utmost importance. The data are recorded as a change in frequency, and any deviation from constant tape velocity in the recording or playback equipment will appear as noise or an error in the signal. Two general approaches to the solution of this problem include refinement of the tape-drive mechanism and the development of methods for compensating or reducing the error introduced by imperfect speed control.

When using separate-sample recording the data may be recorded as pulse-width modulation where the information is proportional to the time duration of the pulse, or as pulse-code modulation where the output of the senser is converted to a digital number and the data samples are recorded sequentially on tape. This method is least susceptible to playback wow and flutter errors since the information is in the form of digits.

In summary, airborne magnetic-tape systems can provide automatic data processing, but at the present state of development their use can only be justified when the quantities of data are very large or if the data processing must be kept current with flight tests.

Senser Outputs Into Radio Telemetering

The last instrumentation system to be considered is the use of radio telemetering to transmit senser signals to a ground receiving station. The system includes sensers, modulators, radio-signal transmitters, ground receivers, demodulators, and recorders.

Before the availability of airborne tape, telemetering was the only way by which the senser signals could be put on ground-based magnetic tape to facilitate data reduction. Now, with airborne tape equipment available, radio telemetering still has several important functions to perform for flight testing. Table 4 lists several:

1 It can be used to provide an operational check on the research vehicle. In high-speed aircraft, the pilot is physically unable to keep track of the many functions which are vitally important to the safety of the airplane. Many of these measurements, such as engine temperatures and pressures, and structural strains, can be transmitted to the ground and displayed to operational engineers who can immediately warn the pilot of dangerous operational conditions.

2 Another important use is to duplicate the airborne recording equipment in the measurement of the basic parameters of the flight test such as airspeed, altitude, and air temperature, insurance against possible loss of data.

3 For the often hazardous initial flight tests on prototype models, telemetering can be used to transmit data concerning the power plant, airplane motions, pilot inputs, and structural strains as a basis for accident-cause analysis.

4 Telemetering may reduce the need for additional flights to attain planned flight-test goals. Where flight results must be examined before the next limits can be set, a whole series of separate flights may be telescoped into a comparatively few tests by employing telemetering as the basis for in-flight decisions.

5 Finally, research telemetering can be used to transmit all of the data to the ground-recording equipment. However, at the present time, because of considerations of cost, accuracy, possible signal-interference and frequency-allocation difficulties, it is not considered practical to employ telemetering for measuring primary research data in piloted aircraft research tests.

Table 4 Flight-Test Applications of Telemetering

1	Operational check
2	Duplicate important measurements
3	Accident-cause analysis
4	Expedite test program
5	Research-data recording

Summary and Conclusions

Summarizing the main criteria we use as a basis for selecting the instrumentation systems for each new research program:

1 The mechanical-optical system should be used for all primary research data.

2 Where large numbers of similar quantities may be surveyed periodically, electrical pickups and commutators working into magnetic tape or oscillographs should be used.

3 Where a few channels of dynamic data are needed, as in the study of vibration and random quantities, recording on magnetic tape should be employed to ease data processing.

4 When hazardous flights are made, or when the complexities of the airplane require too much of the pilot's attention, an operational telemeter should be used.

5 Photographic recording will continue to play an important role in flight-research testing because of its special advantages.

6 Since no one system will provide the solution to all flight-instrument problems, each new job must be examined carefully to insure use of optimum instrumentation.

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Abstracts and Comments Based on Current Periodicals and Events

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Assistant Editor

BRIEFING THE RECORD

High-Density Polyethylene

A NEW fully automated plant for making Bakelite high-density low-pressure polyethylene is now in commercial production, at Institute, W. Va. Production based on Ziegler-type catalysis will be at an annual rate of 30 million lb. These latest high-density polyethylene materials possess a unique combination of properties that are expected to create many new plastics markets. They will also command a share of the present market, including possibly 10 to 15 per cent of that for conventional low-density polyethylene.

DMDA-4901 and DGDB-4100 are high-density polyethylenes produced by a catalytic process under a licensing agreement with Dr. Karl Ziegler. They have improved mechanical properties and heat-distortion characteristics that make them well suited for monofilament applications. The rigidity of sheeting made from these compounds is an important feature in vacuum-formed articles. Its greater crystallinity also provides an effective barrier against greases, oils, moisture, and gases. In both contour extrusions and sheeting, excellent low and high-temperature properties, extremely low coefficient of friction, ease of extrusion, and outstanding batch-to-batch uniformity have brought about the development of many new end applications.

The greater stiffness, reduced permeability, and higher heat-distortion resistance of DMDA-4901 also make it suitable for blow molding. It has four or five times the stiffness of low-density polyethylene. This is advantageous for the production of items requiring greater rigidity and for the reduction of wall thicknesses with resultant material savings.

DMDA-6001 and DMDA-6201 are for injection-molding applications. They offer greater rigidity, excellent toughness at high and low temperatures, high surface gloss, and increased chemical resistance, and provide properties which are intermediate between the present low-density polyethylenes and the more rigid high-impact styrenes, cellulosics, and nylons.

DGDA-4551 has been developed specifically for extrusion coating on paper substrates and offers excellent barrier and handling properties. Extrudability is outstanding. In addition, this new material is harder, stiffer, and has a lower coefficient of friction than conventional low-density materials.

DGDB-4002 lends itself to specific application in both packaging and nonpackaging markets. The major advantages of film extruded from DGDB-4002 are: Low permeability to moisture and gases, resistance to grease and oils, greater stiffness per unit thickness, harder surface, low coefficient of friction without modifiers, and higher temperature range of use.

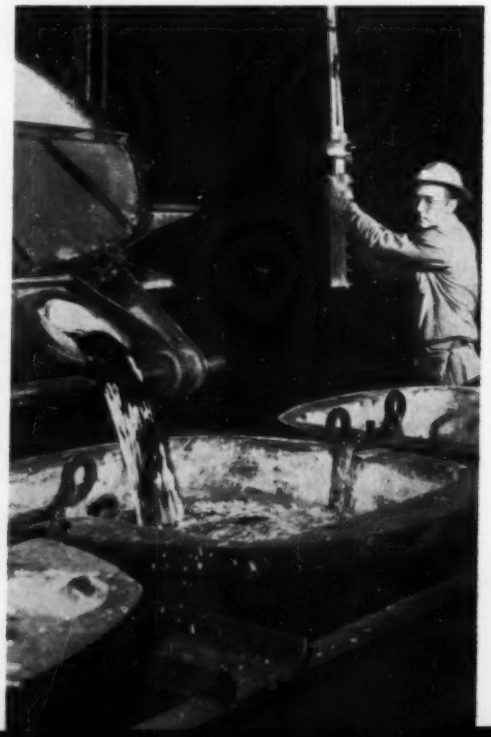
Large Aluminum-Reduction Plant

THE nation's second largest aluminum-reduction plant is now in production. Full scale operation of the $110-million Ormet Corporation facility located between Clarington and Hannibal, Ohio, is scheduled for the end of the year. Ormet is owned jointly by Olin Mathieson Chemical Corporation and Revere Copper and Brass Inc. The new facility has an annual capacity of 180,000 tons of primary aluminum and will receive power from the Kammer Plant of Ohio Power Company at Cresap, W. Va., where the first of three 225,000-kw units will start commercial operation later this month. The plant is currently receiving power from the American Electric Power System. When in full production, Ormet will be the nation's fourth largest aluminum producer.

One reduction pot line is in routine production and will have a daily output of approximately 100 tons of metal; the remaining four lines will be brought in at 60-day intervals with full production by the end of the year.

Ormet was formed in August, 1956, to construct, own, and operate the primary aluminum-production facilities for the two companies. Of the 180,000 tons of aluminum to be produced annually by Ormet, Olin Mathieson will receive 120,000 tons and Revere 60,000.

A push button controls the pouring of molten aluminum into 1000-lb pig molds from a 7000-lb-capacity crucible at the new Ormet plant



Switching engines are in varying stages of final assembly at Alco's new progressive-station multiline locomotive-assembly plant which integrates manufacturing operations in an 1190-ft-long building

Modern Locomotive Engineering

A NEW locomotive-production center and a recently integrated laboratories facility have been completed by Alco Products, Inc. The combined relocation project at Schenectady, N. Y., designed to consolidate production of diesel-electric locomotives and to unite seven laboratories under one roof was built at a cost of more than $4 million. The new locomotive plant is the only straight-line production installation of its type in the world.

The projects were begun last August under a program aimed at streamlining production and reducing over-all plant area to improve efficiencies. Further modernization work is in the planning stage.

Key to the new locomotive-production operation is the company's former general welding shop, an 1190-ft-long building in which Alco has created a progressive-station, multiline assembly system.

With the exception of diesel engines—which are built on separate assembly lines—together with locomotive trucks, hoods, and cabs, fabrication of ready-to-operate units progresses in this building from steel-plate raw material to the completed locomotive.

At the start of this year, Alco held sufficient orders to maintain full-schedule production of locomotives at least through January 1, 1959, and is operating at full production—primarily in fabricating high-power diesel locomotives for the export market. Alco is the world's largest exporter of mainline diesel electrics, and in 1957 the company did nearly 80 per cent of the total export business of all the world's builders.

United in the General Engineering Laboratories center, in what was formerly a maintenance building, are the radiochemical laboratories for nuclear research, a thermal laboratory for study of heat-transfer characteristics, as well as instrumentation, chemical, mechanical, metallurgical, nuclear, and welding laboratories. According to Alco, the centralization of the labs will enable it to keep up and increase the pace of its product-diversification program.

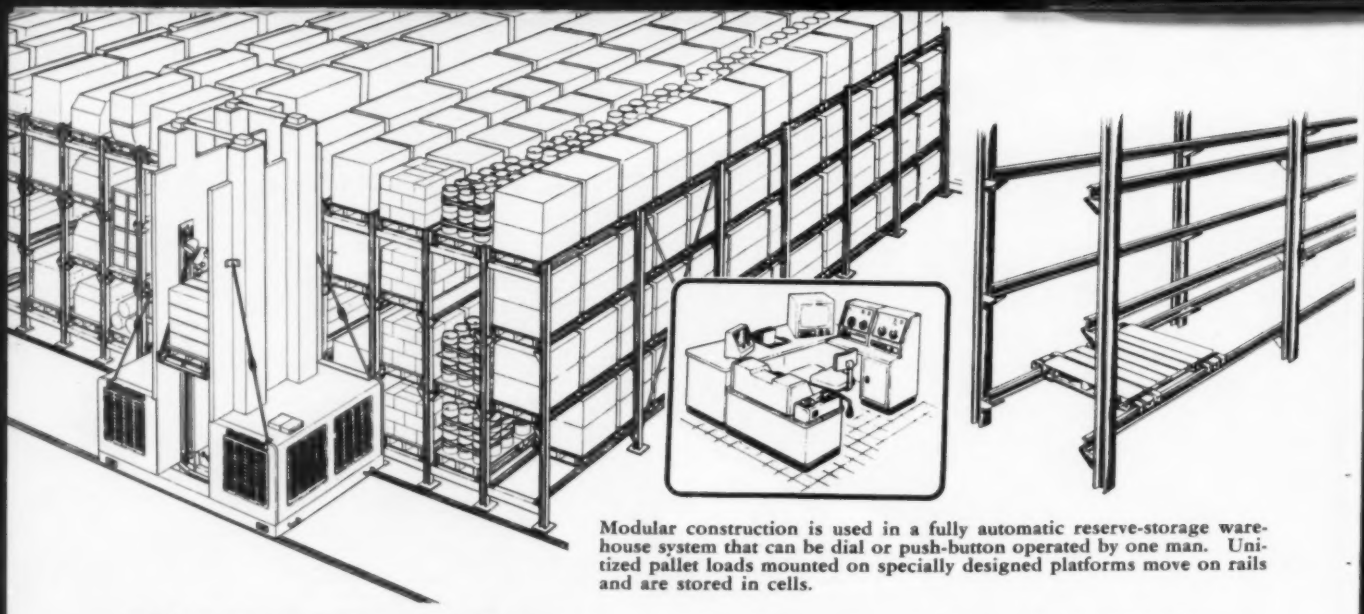
Warning Radar for Cars

RADAR that will warn the driver of an automobile of possible collision is being developed by the Research Laboratories of Bendix Aviation Corporation, Detroit, Mich.

A small concave antenna, mounted in the radiator grill, sends out signals whose reflection is converted into an automatically regulated "beep-beep" sound that tells the driver whether he is closing the gap too rapidly between his car and the one ahead or if he is approaching an object on a possible collision path. The warning signal becomes progressively louder and more insistent.

The signals are limited to objects within the car's safe-stopping distance and ignore situations in which the car ahead is too close but is pulling away. Adjustment is possible for open-country or congested-traffic driving, and background noises that would confuse the signal are minimized.

Drivers readily accommodate themselves to driving with the radar aid which does not depend on other cars having complementary equipment or upon any special highway equipment.



Modular construction is used in a fully automatic reserve-storage warehouse system that can be dial or push-button operated by one man. Unitized pallet loads mounted on specially designed platforms move on rails and are stored in cells.

Fully Automatic Reserve Storage

A RESERVE-STORAGE warehouse system that can double the effective static volume handled by a given warehouse area and effect major economies in space, heat, light, truck investment, and manpower requirements is available from the Automatic Warehousing Branch of Pesco Products Division, Borg-Warner Corporation, Bedford, Ohio.

The new warehousing concept is based on palletized storage of goods and may be either semiautomatic or fully automatic in operation. When fully automatic it can be operated by one man using dial or push-button control. It provides the utmost in space and operating economy where unitized pallet loading is possible to permit picking and shipping without disturbing the pallet.

Modular or building-block construction is utilized. The racking system consists of a series of sloped rails supported at regular intervals by uprights which utilize controlled gravity feed to provide live roll-through storage. The units formed by the rails and uprights are called cells. Racking systems are generally designed to be 3 or 4 cells high. Rail length is optional and may be sufficient to accommodate up to 15 pallets if required.

A fully automatic 50,000-sq-ft installation can accommodate 12,000 pallets. This compares with 6000 pallets in a well-planned 50,000-sq-ft warehouse of conventional design. A typical installation with a single loader and unloader operates on a 2-min cycle for either loading or unloading, giving a production capacity of 30 pallets in and 30 pallets out per hour.

Cell design is tailored to meet the needs of a given installation. The racking system can be designed to accommodate pallets from 32 in. sq to 5 ft sq.

Height of each cell is determined by the palletized product and may be altered easily and quickly when required.

The rack is served by an automatic loader at one end and an unloader at the other, also designed and built by Pesco. Each can accommodate two pallets and handle a total load of 8000 lb or 4000 lb per pallet.

The loader unit is powered by separate electric-motor drives for lateral and vertical motions and moves on way-type tracks which parallel the rack face. Positioning is accomplished hydraulically and hydraulic cylinders are used for operation of the pallet table.

Pallets are mounted in specially designed pallet carriers which are small-wheeled platforms with tubular wheels flanged at the outer end for positive engagement of the rails. These provide broad-rolling-contact surfaces in order to compensate for minor variations in rail-to-rail width.

Side rails are U-shaped channel sections. Channel depth exceeds wheel OD and prevents the wheels from touching floor or dock when the carrier is placed down away from the racking system so that it will not roll.

Normal handling of the pallet carrier is easy and positive; methods and procedures of handling the pallet carrier are the same as those familiar to users of conventional material-handling equipment.

In a typical loading cycle, the operator first dials row number and cell height. The palletized load is automatically picked up by the loader unit which begins to move to the designated cell. Acceleration is positive and rapid.

As the loader advances, it determines the correct row by means of a photoelectric-cell counting system, which counts inches rather than rows for maximum accuracy. As the loader approaches the designated row, it automatically decelerates and the load elevator begins to move up. When the loader reaches the row, its lateral drive motor is idled and the loader is automatically centered on the desired row. The elevator continues its upward travel and is automatically positioned at the proper cell height.

Hydraulic cylinders then raise the load table to clear the elevator. The table automatically advances to load the pallet on the cell rails, then retracts to its neutral position. The loader and elevator then return to zero position to pick up the next load.

Operation of the unloader is identical and reversed, except that a third digit may be dialed to deliver the selected pallet to a predetermined unloading point.

To permit mixed-product storage, return rails may be provided in the racking system. With this arrangement, it is possible to pick not only row number and cell height, but pallet number as well. When a signal to pick other than the end pallet is received by the unloader, it moves to the designated row and cell height and first transfers to the return rails the pallets ahead of the one specified. The desired pallet is then picked and unloaded in the manner previously described.

Shippingport Dedicated

THE world's first large-scale commercial nuclear power plant devoted entirely to the production of electricity was dedicated at Shippingport, Pa., on May 26, when President Dwight D. Eisenhower opened the main throttle valve from Washington, D. C., by using a neutron source to send an impulse to Shippingport.

The 60,000-net-electrical-kw pressurized-water-reactor plant, which first went critical in December and produced electricity a few weeks later, has been undergoing careful testing. The plant is the largest to date to be put into operation under the AEC's Civilian Power Reactor Program. The primary purpose will not be to furnish continuous power with a maximum load factor but to advance the technology and give reliable cost estimates for the pressurized-water type of reactor.

Enriched-uranium plates clad with an alloy of zirconium as protection against the hot water, and hollow zirconium-alloy rods filled with natural-uranium-oxide pellets are used in a seed-and-blanket core arrangement. Heat liberated in both regions is carried through a primary loop to the steam generator. The water in the secondary loop is converted to steam to operate the turbine-generator. To attain the desired electrical output the reactor must produce about 790 million Btu per hr or about 231,000 kw of heat energy within the reactor at an average coolant temperature of 523 F.

The reactor type takes its name from the fact that water in the primary loop is maintained at 2000 psi to prevent boiling. Heat from this water is transferred to the steam system which operates at 600 psia.

Other design objectives were that the first core should last 3000 hr at full-power operation and refueling should be accomplished with minimum shutdown. Commercial equipment was to be used wherever possible; reactor control was to be as simple as possible; and cost was to be the minimum consistent with these requirements.

The over-all estimated cost is $121,400,000, of which $98,400,000 represents government funds, $22½ million the contribution of the Duquesne Light Company, and $500,000 that of the Westinghouse Electric Corporation. Plans call for 130 men to operate the station.

The meter climbs from 0 to 60,000-kw full power at Shippingport, *below*. Watching, *left to right*, Congressman James E. Van Zandt; Westinghouse atomic power manager Charles H. Weaver, Mem. ASME; Duquesne board chairman Philip A. Fleger; AEC chairman L. L. Strauss; and Westinghouse president Mark W. Cresap, Jr.

The Armour Dust-Fueled Reactor

FINE-PARTICLE fissionable material, such as uranium oxide or uranium carbide, entrained as dust in a gas such as helium would be used in a novel reactor system. The advantages of any fluid-fueled system with greatly reduced corrosion and inherent high-temperature capabilities are claimed, and temperatures of 2000 to 3000 F appear feasible in an all-ceramic system. The system appears promising for process-heat, electric-power, or high-flux-testing applications.

The conceptual study for this type of reactor is described in a paper by D. Krucoff and F. Narin entitled "The Armour Dust-Fueled Reactor (ADFR) Concept," presented at the 1958 Nuclear Congress, Chicago, Ill., March 17–21, 1958.

No fuel-element fabrication or reprocessing cost would be involved; there would be unlimited burnup, excellent heat transfer to the working fluid, and control would be effected easily by varying the fuel concentration. Control rods would be unnecessary and scram produced simply by opening valves to release part of the mixture to an adjacent chamber, thus bringing the fuel concentration below criticality.

Helium is nearly an ideal carrier from the nuclear, chemical, and heat-transfer points of view and would virtually eliminate the corrosion problem. Externally and internally cooled systems could be considered with the latter providing a nonradioactive primary loop.

The concept is analogous in many ways to a liquid-metal-fueled reactor. The core would be simply a block of ceramic moderator material such as graphite or beryllium oxide with through holes for the passage of the fuel-laden helium. Ducts and chambers in contact with the fuel could be lined with abrasion-resistant silicon carbide or with aluminum oxide depending on the moderator, and covered with a gas-tight metal skin.

Flux and power densities would be limited only by erosion effects that would set an upper limit to fluid velocity through the core. Furthermore, the flux plot is flat with a remarkably low deviation of only about 10 per cent in the outer layers.

Fuel would be prepared by grinding in a ball mill, or by attrition in opposing jet streams. Average particle sizes of 1 or 2 microns are obtainable, and these are expected to be markedly reduced during reactor operation due to mechanical attrition, the process, and radiation.

Fission-product removal is accomplished with a small bleed stream which passes the fluid into a cooling and settling chamber in which the larger particles are removed. After this, an electrostatic precipitator is used to remove all particulate matter, including fuel dust. The remaining gas would then be passed through a low-temperature charcoal bed to remove all gases from the helium, which would be returned to the system. Breeding should also be feasible.

Nuclear Gas Turbines

Since nuclear reactors are not inherently temperature-limited, the high-temperature efficiency of the gas-turbine cycle makes the combination of the two especially attractive.

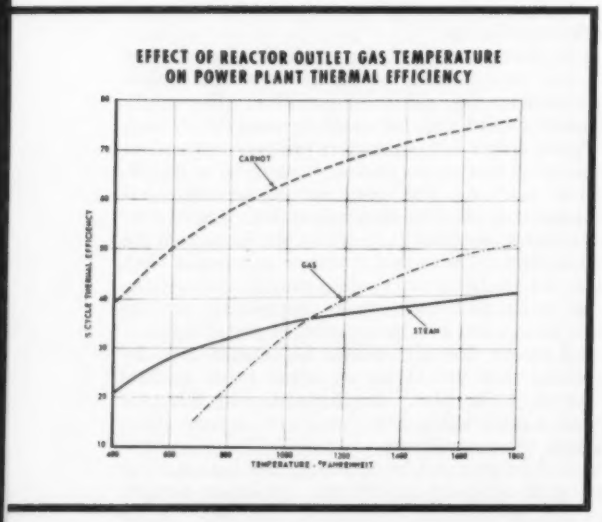
According to a paper by Louis H. Roddis, Jr., "Nuclear Reactors as an Energy Source for Gas Turbines," presented at the ASME Gas Turbine Conference and Exhibit, Washington, D. C., March 2–6, 1958, both the gas turbine for use with a gas-cooled reactor, and the high-temperature gas-cooled reactor itself, are both advanced concepts.

Below reactor outlet temperatures of about 1100 F there is little incentive to go to gas-turbine cycles for efficiency reasons alone, and their use in that range will be limited to specialized applications.

In the reactor art to date, temperature limits have generally been well below 1100 F, so that nearly all power reactors have been built or are being designed with steam-turbine cycles, operating with reactor outlet temperatures in the 500 to 800-F range. Active projects in the high-temperature range were started only recently. However, one early effort, the Daniels Pile, was not completed because of the meager knowledge of 11 years ago.

Cycles

Nuclear gas-turbine systems can be constructed employing either the open or closed turbine-cycle design, and can be either direct or indirect with respect to coolant circulation between the reactor and the turbine cycle.



The open direct cycle dictates the use of air as the cycle fluid on this planet, which introduces corrosion problems and the danger of releasing radioactive contamination directly to the atmosphere. The open turbine cycle with a closed indirect reactor-coolant cycle appears to offer no advantages if gases are used to cool the reactor, but does offer special advantages if liquid reactor coolants are used. The closed-cycle turbine operating indirectly with a closed reactor-coolant system has no apparent point for gas coolants, and investigations of this type of liquid-coolant use are still in the preliminary theoretical stage.

Ultimately the gas turbine using a nuclear energy source will undoubtedly employ the direct closed cycle because of its advantages in plant simplicity and weight and space reduction, maximizing thermal efficiency and minimizing reactor-core temperature level. These advantages are particularly compelling as applied to mobile, or portable, power and propulsion plants for military or civilian uses. The discussion of reactor characteristics and materials which follows is confined to this direct closed cycle.

Reactor Characteristics

A gas-cooled reactor used in direct-cycle operation would need a relatively large core volume since gas coolants are relatively poor heat-transfer mediums. It would have to operate at a temperature high enough to achieve efficient operation of the gas turbine. The large core volume would require essentially thermal or "slow" neutron operation.

The extremely high operating temperatures and temperature gradients required in the nuclear portion subject every part of the reactor complex to great strains—physical, chemical, and nuclear. Further, at any practical pressures the gas coolant constitutes a "void" in the reactor creating difficult design problems from a nuclear physics standpoint.

Materials for Use

The following are some of the special conditions created by the high-temperature operation of these reactors:

Fuels. Most known metals appropriate for their nuclear properties, namely, uranium or plutonium, would melt or otherwise lose their integrity in such intense heats. Matrices of nonmetallic fuels in high-temperature metallic alloys, however, might possibly be suitable for a limited range of lower gas-cooled reactor temperatures. The most likely higher temperature fuel elements are oxides, silicides, or carbides of uranium, alone or dispersed in nonmetallic structural materials, or plutonium in similar nonmetallic forms. Thorium may ultimately be present in some designs as a fertile material to produce U-233 as a fuel.

Moderators. Moderator materials presently believed capable of remaining intact under extreme conditions are: Beryllium as a metal or an oxide, graphite, certain metallic hydrides and deuterides such as zirconium hydride and deuteride, and silicon carbide. No other engineering materials can do the moderator job.

Structural materials. Most high-temperature structural materials, such as the cobalt alloys and the higher alloy steels, are also high neutron absorbers. Only small quantities can be used if the nuclear reaction is not to be adversely affected or completely stopped. To provide a reasonable compromise between nuclear and mechanical needs, rather expensive and unusual materials are required. Some of these are: alloy steels, high-temperature gas-turbine blade alloys, Inconels, molybdenum, tantalum, graphite, tungsten, and other more exotic materials such as columbium.

Coolants. The coolants cited most frequently for use with reactors in direct closed-cycle gas-turbine systems

are: (*a*) helium, (*b*) nitrogen, pure or impure, (*c*) carbon dioxide, and (*d*) air.

Helium, in spite of its rarity, offers considerable theoretical promise. It has good nuclear properties, is unaffected by core radioactivity, and is inert chemically. It must, however, be highly compressed in order to take full advantage of its superior heat-transfer properties, and it is so difficult to contain that it is frequently employed to detect leaks in the system. However, no turbine operating on helium has yet been developed. Critical dependence upon the purity of the gas to prevent it from becoming radioactive would require a degree of shielding to the external circuit, since contaminants are likely.

The ready availability of nitrogen and its general similarity to air for turbine-design purposes are important advantages although there is some nitriding effect. Nuclear properties depend on purity and the system external to the reactor would require some shielding.

Although carbon dioxide is relatively common and inexpensive, indications are that its behavior at the high temperatures and pressures needed for high over-all cycle efficiency depart very greatly from perfect-gas laws. If future experiments bear out these indications there is promise that it may be a better cycle fluid than has generally been believed to date. However, its chemical reactions are far from well-understood, and the theoretical chemical thermodynamics do not appear too favorable in some cases, although it is an excellent and widely used fluid at the lower temperatures required for steam-cycle operation.

Air is of interest chiefly in open systems and appears to have no advantage over nitrogen in nearly all cases when the closed system is considered. It has substantial disadvantages relating to its corrosive effects and its nuclear properties.

The Daniels Pile project, an intensive effort to exploit beryllium oxide as structural material and moderator, and helium as coolant, was begun at the predecessor to the Argonne National Laboratory in 1945.

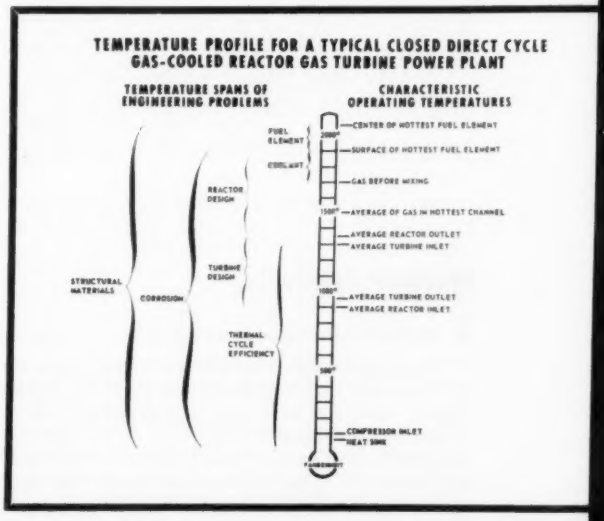
The many problems connected with the required heat ranges on this first power-reactor effort anywhere in the world proved overwhelming and the project was abandoned at the end of 1947. The technical problems involved are largely with us today, although we are now more optimistic about their solution. They were: (*a*) The start-up problems inherent in a pressure change in a large system operating at different power ratings and temperature levels; (*b*) the thermal-stress problems incident in the fuel element at both the high temperature differences and rapid thermal cycling; and (*c*) the problems of piping large volumes of hot gas around in a system which must inevitably change temperature.

At about the time of the Daniels Pile, the United States became interested in the gas-cooled reactor for aircraft propulsion. Only three things can be said about this: (*a*) In 1954, the Aircraft Reactor Experiment, a liquid-salt-fueled and cooled reactor, was operating at Oak Ridge, Tenn., with temperature levels which could have permitted gas-turbine operation on an indirect open cycle although the heat was actually dissipated; (*b*) in 1956, an aircraft gas turbine was operating by nuclear power at the National Reactor Testing Station in Idaho; and (*c*) the AEC is not unaware of the problems of high-temperature gas-cooled reactor operation.

Another gas-cooled reactor project for use with gas turbines is the Gas-Cooled Reactor Experiment now under construction at NRTS, Idaho. This project is primarily of interest to the Army as a power plant which has portability potential and does not require cooling water.

The Maritime Gas-Cooled Reactor, an even more recent addition to the U. S. program, would be a prototype of a propulsion unit for a merchant ship. Various design studies have been completed on this project, and in January the Atomic Energy Commission selected a contractor to undertake development of this reactor. Other gas-cooled reactors in the U. S. are in use for research with air as the coolant, but do not operate at the high temperatures which would make them suitable for use as energy sources for gas turbines, or are based on the steam-turbine cycle.

In Europe, a number of reactors have been gas-cooled. In the United Kingdom and France power has been produced by gas-cooled reactors through the steam cycle at temperature levels in the 600 to 800-F range. Several other gas-cooled power-producing reactors using the steam cycle are under construction in the United Kingdom, France, and possibly the USSR (although the latest published reports make no mention of a previously announced unit of this type). The only serious work looking at reactors for gas-turbine operation in Europe seems to be in Germany and Holland where very small efforts are under way on power-producing units, and in France where a reactor experiment is to be constructed. Since the USSR has announced work on a nuclear-propelled aircraft, they may also be working on gas-turbine cycles.



The author concluded that problems of cycle selection, systems analysis, reactor design, and above all, of materials development, must be solved before there can be really practical closed-cycle gas-turbine operation from nuclear heat sources in the higher temperature ranges.

The author acknowledged assistance from AEC staff members: Irwin E. Jackson, charts and technical information; George A. Upman, drafting; and Joseph B. Epstein, editorial assistance.

The Transistor's First Decade

JUST ten years ago, the transistor was invented during a basic-research study of the surface properties of germanium at the Bell Telephone Laboratories.

Since then, this completely new oscillator, modulator, and amplifier has been applied to telephone circuits, the miniaturization of hearing aids and radio sets, the development of personal-communication radio systems, miniaturization of computers, electrical switching applications, and a host of other devices that formerly utilized the vacuum tube.

An estimated 10,000 vacuum tubes, located along the way, for example, are required to amplify a New York to Los Angeles call, and will in time give way to the transistor. A personal-signaling radio receiver that would be out of the question with vacuum tubes because of power consumption will soon make it possible to extend the telephone bell to the vest pocket and deliver messages that cannot be overheard by other receivers.

The basic switching functions—in particular, logic, memory, and connecting—can be more efficiently performed by transistor than by the vacuum tube. The miniaturization possibilities, dramatically demonstrated by the artificial-satellite applications, are having a widespread effect on military devices where the computer is an important part of tracking and aiming equipment for weapons.

The Bell System has a vital interest in data processing with the complications that are involved in billing phone calls. Through special converters their system will take input data from Automatic Message Accounting tape, punched cards, teletypewriter tape, toll tickets, and customer-payment stubs. A calculator will perform the arithmetical and logic operations, as well as the sorting, arranging, merging, extracting, and deleting operations.

The entire June issue of the *Bell Laboratories Record* is a summary of the research, development, and application of the transistor. The scientific importance of the invention which has brought such a rapid evolution if not revolution to the communications field, was recognized with the award of the 1956 Nobel Prize in Physics to J. Bardeen, W. H. Brattain, and W. Shockley of the Laboratories staff.

Aqueous Homogeneous Reactor

A THOROUGH conceptual-design study of asingle-fluid two-region aqueous homogeneous reactor, SFTR, has recently been completed by the Nuclear Power Group composed of seven electric utility companies, the Bechtel Construction Corporation, and The Babcock & Wilcox Company. The reactor studied operates on the U-233 Th-232 cycle, and uses a ThO_2 pellet blanket, arranged in 14 cylindrical assemblies around the periphery of the core region.

Blanket cooling is accomplished by flowing the core fluid, a uranyl-sulfate heavy-water solution through the blanket assemblies and into the core region. This arrangement is expected to minimize the corrosion by the core fluid and also provides for relatively easy replacement of the blanket containers. The 14 blanket assemblies are rotated to minimize absorption of neutrons by protactinium 233 and to equalize the breeding of U-233 in the blanket.

The study was based primarily on the experimental data from the Oak Ridge National Laboratory homogeneous-reactor project, and the results are based upon a reactor system which could be built with present technology. Further research costing between $5 million and $10 million would be necessary to prove the design.

Estimated net energy costs of 17 to 19.6 mills per kwhr might be compared with U. S. estimates of energy cost for the pressurized-water reactor and the British Calder Hall-type of 19.6 and 17.9 mills per kwhr.

Information is from the Nuclear Technology Briefs on Power Reactors prepared for the AEC by the General Nuclear Engineering Corporation, Dunedin, Fla.

Nuclear Briefs

▶ Newest Atomic Submarine

THE *Skipjack*, forerunner of a group of high-speed, high-performance attack-type nuclear-powered submarines designed from the keel up for maximum underwater performance, was launched in May at the Groton, Conn., shipyards of Electric Boat Division, General Dynamics Corporation. The sub's reactor plant was designed and developed by Bettis Atomic-Power division of Westinghouse Electric Corporation under the direction of and in technical co-operation with the Naval Reactors Branch of the AEC.

▶ Airborne Reactor Moved to Oak Ridge

The "flying" nuclear reactor designed and built for the U. S. Air Force at Convair (Fort Worth, Texas) Division of General Dynamics Corporation has been moved under guard to Oak Ridge, Tenn., where it will be suspended from four 300-ft towers to culminate several years' study of radiation patterns for use in the design of compartments to protect the crews of nuclear-powered airplanes.

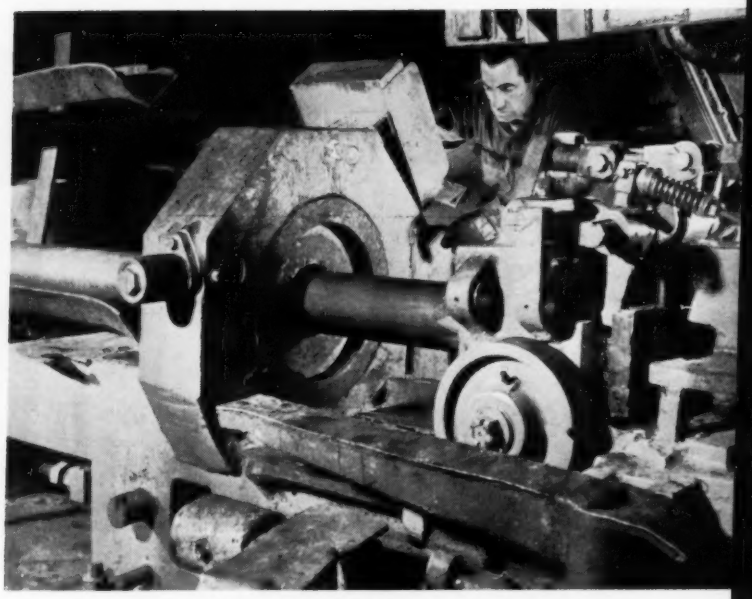
The portable water-cooled reactor which operates at power levels up to 1000 kw made 47 experimental flights from Fort Worth aboard a modified but conventionally powered B-36 bomber, the NB-36H. The world's first airborne reactor, it incorporates flexible shielding.

▶ SRE Operating at Design Power Level

The design power level of 20,000 kw of heat has been reached by the Sodium Reactor Experiment, SRE, operated for the Atomic Energy Commission near Los Angeles, Calif., by Atomics International, a division of North American Aviation, Inc. Operation at full power followed a scheduled series of low-power tests of the reactor core, coolant systems, and related components which began last year.

Experience gained from the SRE is being used by Atomics International in development work for the 75,000-net-electrical-kw central-station nuclear power plant being built by the AEC and Consumers Public Power District of Nebraska.

This small, light, 4-cyl diesel with good fuel economy at average operating speeds may be substituted for piston engines in cars and trucks



Tube cold-drawn through a 7-in. Carboloy cemented-carbide die has an improved finish, and can be drawn faster and at lower die cost per foot than with steel

Diesel for the Motorist

A SMALL 4-cylinder high-speed diesel engine combining the advantages of diesel-engine power and economy with gasoline-engine speed and flexibility has been developed by F. Perkins, Ltd., of Peterborough, England. Continental Diesel Corporation, Brooklyn, N. Y., is agent.

The 1.6-liter diesel engine, known as the "Four 99," has been developed after six years of research and intensive trials covering more than a million miles with cars, trucks, and taxis under all conditions.

The engine is both compact and light, weighing only 320 lb. It develops 43 bhp at 4000 rpm for cars and 42 bhp at 3600 rpm for trucks; an industrial version is also available rated at 32 to 35 bhp at 3000 rpm.

During Royal Automobile Club tests, a Vauxhall Velox averaged 56.6 miles per gal at an average speed of 34.8 mph, and a Ford Consul made 50.8 miles per gal at an average speed of 34.7 mph.

Cruising and top speeds of cars fitted with the Four 99 have proved equal to those of similar cars with gasoline engines. A top speed of more than 80 mph has been obtained with some cars. Big mileage without major overhaul is in view for small-vehicle owners.

A Bedford truck with a 15-cwt load completed 101,202 miles on a high-speed test track with a consistent speed of 56 mph, and average fuel consumption of 37 miles per gal.

The industrial version will provide the first 4-cyl water-cooled diesel engine for a wide range of small industrial equipment, including lighter types of fork-lift trucks, compressors, generators, dumpers, pumping sets, and cranes. It can easily be installed in many kinds of equipment now powered by gasoline engines at reduced costs for industrial operators.

Perkins is offering special conversion-engine sets to replace gasoline units in several British-made cars.

Carbide Dies

CARBIDE DIES are used exclusively for drawing 7-in. oil-well casings at Pittsburgh Steel Company's Allenport Works because they cost only one-fifth as much as steel dies for every foot of casing produced. Cemented-carbide dies also reduce the number of scrapped tubes, give a better finish and permit faster drawing than is possible with steel dies, the company has found.

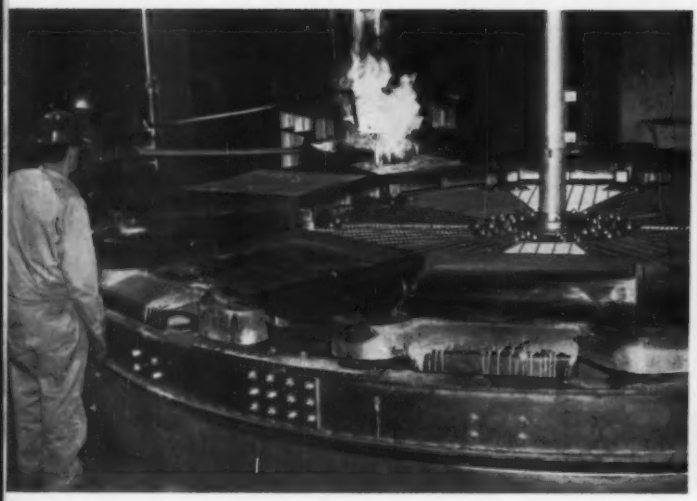
Pittsburgh Steel's records show that a steel die, costing $50, produces an average of 3200 ft of 7-in. casing before it is permanently withdrawn from service. A carbide die, which costs $1250, plus finishing work, averages 400,000 ft of drawn casing, or 320 ft for every dollar invested in carbide dies, against 64 ft per dollar in steel dies.

Amount of scrapped or rejected material is less because of the smooth surface of the carbide and rejects by die failure have been eliminated.

The extreme hardness of cemented-carbide dies gives the tubes a better as-drawn surface finish, improving the quality of the product.

On Pittsburgh Steel's cold-drawing benches, production is at speeds impossible with steel dies. Casing hits the die shoulder at a speed of 20 fpm, and before going more than 2 ft, it is traveling at a rate of 50 to 60 fpm.

Dies with nibs of Carboloy cemented-carbide grade 55B arrive from General Electric Company's Metallurgical Products Department, Detroit, Mich., rough drilled to 6.990. Die finishing removes about 0.025. Drawing begins with a die 7.015 in diam. The die stays in use until diameter increases to 7.035. The dies are returned to Pittsburgh's mandrel and die shop every 16 hr for servicing to maintain uniform quality and prolong die life. The longest carbide-die run at the Allenport Works so far is 590,000 ft of tubing, with the next longest 550,000 ft.



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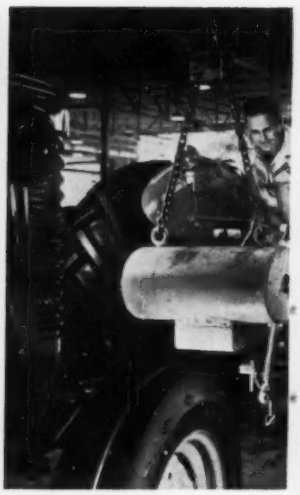

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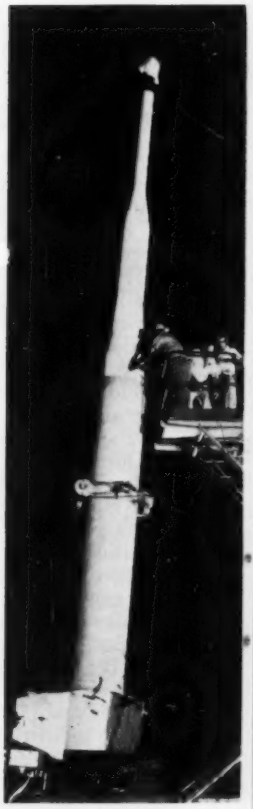

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1 No Sloshing. A Westinghouse Magamp system permits casting of molten copper into anodes on a rotating table without sloshing at the Inspiration Consolidated Copper Company, Inspiration, Ariz. Any jerking or sloshing would disturb the crystal structure of the cooling copper. A 1200-rpm motor geared down to 0.24 rpm rotates a loaded 25-ft-diam 50,000-lb wheel, accelerating or decelerating between zero and "top speed" in 10 to 25 sec.

2 Flexible Mandrel. A new type of flexible ball mandrel permits top-quality bends to a radius of twice the tube diam in thin-wall tubes. Pines Engineering Company, Inc., Aurora, Ill., has been licensed to manufacture and sell the Free-Flex mandrel which was developed by Boeing Airplane Company personnel at the Wichita, Kan., Division. Common sizes ranging from 1 to 6 in. in diam will be available, and up to 10 times as many bends may be made without expensive reworking. The balls, which will flex in any direction, can be changed or added with only a screwdriver.

3 Tractor Plant. The hydraulic system in a tractor is checked and adjusted at the new Massey-Ferguson Tractor Plant in Detroit, Mich., which was recently doubled in size. A 2-mile-long conveyer system with 96 individual stations for assembly and other operations permits completion and test driving of 250 tractors during a single shift—one every 2 min.

4 Automatic Cam Analyzer. A completely automatic machine, developed by Airborne Instruments Laboratory, Mineola, N. Y., and International Business Machines Corporation, performs a complex inspection operation with a reduction of 60 to 1 on inspection costs. The machine makes a permanent chart of recorded cam errors, audibly warns if any tolerance is exceeded, and makes a continuous arithmetic check of dimensional changes from point to point in 36 min where 12 hr were previously required. There are 2160 separate point inspections with a tolerance of $\pm$ 0.0001 in. of desired radius, maximum error change between any two measured points must not exceed $\pm$ 0.0001, requiring 2160 more calculations.

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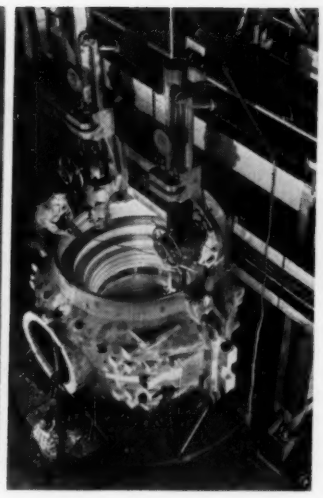

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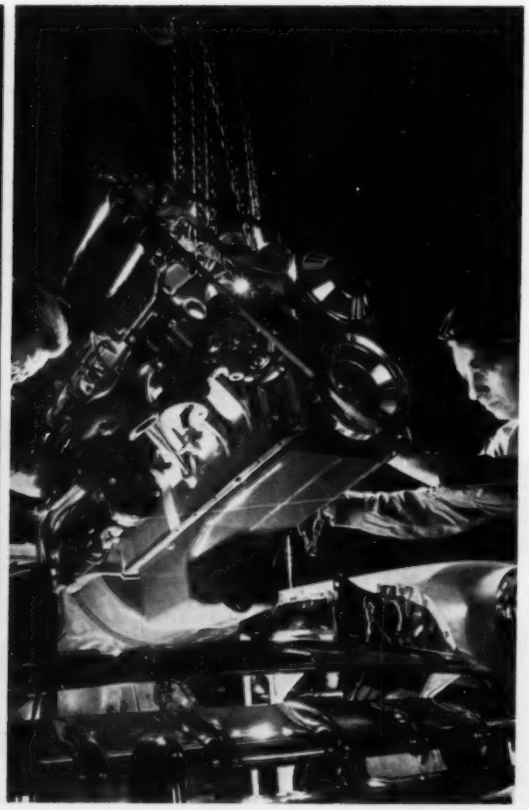

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5 Intricate Machining. A 100,000-lb cast-steel cylinder blade ring for a high-pressure steam turbine is intricately machined in a 25-ft boring mill at the Union Steel Division of Blaw-Knox Company, Pittsburgh, Pa. Walls of varying thickness, extremely close dimensional tolerances, and an interior honeycombed with passageways for the steam complicate the cutting of ⅝-in-wide 4 to 5-in-deep grooves sloped at a 45 deg angle.

6 Re-entry Tests. The Air Force has successfully brought back more than 20 nose cones from outer space through the earth's atmosphere. A final checkout of one of the 40-ft-tall Lockheed X-17 ballistic rockets which carried them is here being made at Cape Canaveral, Fla.

7 Aluminum Auto Engines. Three experimental aluminum V-8 automotive engines weighing about 30 per cent less than cast-iron V-8 engines, the result of six years of development by General Motors, have already undergone successful laboratory and road tests.

Engineering Progress in the British Isles and Western Europe

J. FOSTER PETREE
European
Correspondent

EUROPEAN SURVEY

German Industries Fair, 1958

THE most noticeable changes which distinguished this year's German Industries Fair, held in Hanover from April 27 to May 9, were at the southern end of the Fair ground, where three new buildings have been constructed. All three were devoted to various branches of the electrical-engineering industry. The central block, Hall 12, 164 ft high, was entirely occupied by makers of electric-lighting fittings, apart from one floor of restaurant space and the ground floor, which forms the southern entrance to the Fair. Adjoining it is the two-story Hall 11, containing radio, television, and communication equipment; and on the other side—the large L-shaped building—is Hall 13, in which were displayed motors, generators, transformers, switchgear, and so forth. From the constructional point of view, this is perhaps the most interesting of the three buildings, as it has a clear internal width of about 225 ft between the walls, with no internal supporting columns whatever. The ceiling is suspended from steel tubular girders of 70-m span, constructed by the Mannesmannröhren- und Eisenhandel G.m.b.H., of Berlin-Charlottenburg. With the previously existing two-story Hall 10, which contained accumulators, rectifiers, cables, insulating materials, and such, the Zentralverband der Elektrotechnischen Industrie (the Central Association of Electrical Engineering Industries) thus had at its disposal more than a million sq ft of exhibition space. Foam concrete has been used extensively in these new buildings. By enabling the electrical exhibits to be concentrated in one area, they have released space elsewhere which was badly needed by the general engineering industries; for example, a new Hall 8 (North) has been built, with nearly 28,000 sq ft of floor space, which was allocated to compressors, air-conditioning plant, refrigerators, and food-processing and laundry machinery; and Hall 2 was extended to provide better accommodation for gearing, gear drives, and ball and roller bearings. The total indoor area available in the 1958 Fair amounted to 270,000 sq m (rather more than 2,900,000 sq ft), to which the open-air stands add a further 150,000 sq m of exhibition space. The exhibitors numbered more than 4300, of whom about 1250 were concerned with mechanical engineering.

Correspondence with Mr. Petree should be addressed to 39 Mayfield Road, Sutton, Surrey, England.

Interior of new display hall at German Industries Fair, *left;* building has clear internal width of about 225 ft between walls with no internal supporting columns. *Center,* gearing, gear drives, and ball and roller bearings are on display in another of the halls at the Hanover Fair. *Right,* over-all view of three new buildings at German Industries Fair Ground. All three are devoted to the electrical-engineering industry. Fair was held April 27–May 9, in Hanover, Germany.

New Foundry for Ford Motor Company

THE Ford Motor Company, Ltd., has now brought into full production at Dagenham, Essex, England, its new Thames Foundry, which they claim to be "one of the most advanced in the world" and superior to any in Europe. It has cost the equivalent of $21 million and is one of the most important items in a modernization program, begun in 1954, which will have cost between nine and ten times that amount when it is completed next year.

The new foundry, which employs 1800 operatives, is planned for a daily output of about 400 tons of finished castings, representing about half of the total output of the British Ford plants. The principal components produced are cylinder blocks and heads and the large castings for tractors.

The unit comprises two buildings, the larger of which, 1200 ft long, 180 ft wide, and 70 ft high, is devoted to the main operations of molding, core-making, melting, casting, and fettling. In the smaller building, 700 ft × 60 ft in plan and also 70 ft high, are the sand-handling and drying plant and the sections for cooling, grinding, and cleaning the castings.

The main operating floor is divided into bays 60 ft square, with steel columns supporting lattice girders from which are suspended the sand-distributing system, the monorail conveyers, and the storage hoppers for materials, thus providing the maximum of free working space on the floor. There are four hot-blast cupolas, 108 in. in diam, each with an 8-ton receiver for the hot metal. Electric hoisting and towing units on the monorail conveyers take the ladles to the pouring station. Each of the two molding lines has its own automatic sand system, and in each line there are eight semiautomatic molding machines, working within a continuous conveyer.

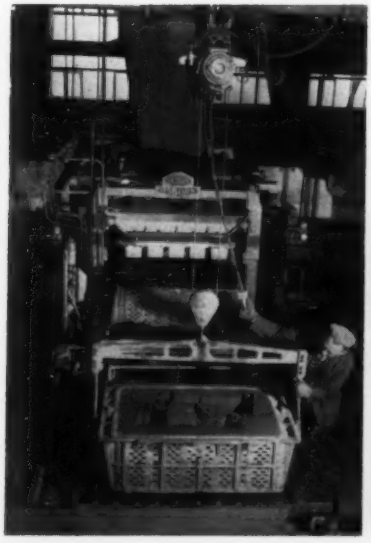
The castings are removed from the drag mold by hooks suspended from a conveyer running immediately above the mold conveyer and turning away from it to the cooling section in the adjoining building, where they stay for about three hours before having the internal sand and cores removed. They then pass through a battery of grinding machines and are conveyed back to the main building, where they are distributed among eight fettling lines for finishing and, if required, water-testing.

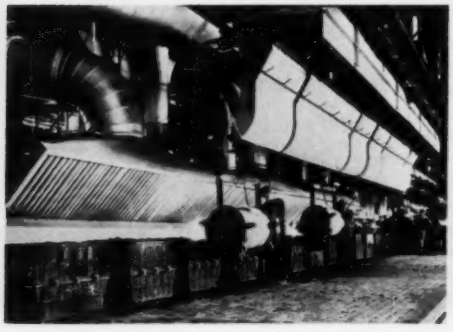
The core sand is mixed at a central high-level station in the main building, the mixing being entirely automatic, under punched-card control. The mixed sand is then conveyed pneumatically to the 39 semiautomatic vertical core-blowers, from which the cores are transferred by conveyers to the five continuous horizontal ovens.

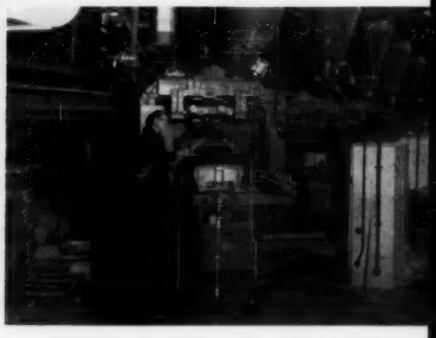
There is an exceptionally complete ventilating system, taking in 1,200,000 cu ft of air per min and providing a complete change of filtered air every 8 min. A central sluicing system with a circulation of 5000 gpm of water removes the cupola slag and the deposits from the dust collectors. The dust-laden water is discharged to settling tanks and eventually recirculated.

Pig iron and coke are brought into the foundry by rail, the coke being in containers to save breakage.

A telpher system, which also handles the limestone, lifts the containers from the rail cars to the storage hoppers. Ordinary skip hoists are used to charge the cupolas. Wherever possible, manual work has been either eliminated or greatly reduced, to the extent that the electricity requirement for the plant is some 15,000 kva, which is distributed through five substations on the roof of the main building. As a result, it has been found that the output per man-hour is twice that achieved in the old foundry.







Automatic molding machine of the jolt-squeeze straight-through type; *left,* half mold and flask are being transferred from molding machine to mold conveyer. Pouring heavy castings; *center,* 2000-lb ladles are hoisted and towed electrically from cupolas to pouring stations. *Right,* core-making line equipped with six core-blowing and core-stripping machine units on which various cores for tractor castings are made.

Substance in Brief of Papers Presented at ASME Meetings

M. ZANFARDINO
Staff Editor

ASME TECHNICAL DIGEST

Oil and Gas Power

Development of a Turbocharged Uniflow Two-Cycle, Spark-Ignition Gas Engine.....58—OGP-12

By W. M. Kauffmann, Assoc. Mem. ASME, Worthington Corporation, Buffalo, N. Y. 1958 ASME Oil and Gas Power Conference paper (multilithographed; available to March 1, 1959).

Starting with the development in 1912 of the first all-American twin-cycle, horizontal, air-injection diesel engine, the author outlines the theoretical and practical considerations which have been applied to produce today's turbocharged uniflow two-cycle, spark-ignited gas engine.

The development work described in the paper has demonstrated that the uniflow two-cycle gas-compressor engine with self-sustained turbocharging provides optimum delivery ratio of combustion air to maintain low mean-cycle temperature. It provides means for timing of blowdown of the exhaust gases to the best release point for utilization of the kinetic energy of the gas in the exhaust pulse, or pressure level, ahead of the turbine inlet. This is obtained without delaying or impairing the closing point of the exhaust (as would be the case in ported engines) thus permitting the maximum trapped air volume at the lowest turboblower-discharge pressure.

It appears, therefore, that only thermal load of the combustion-chamber critical parts limits the maximum potential output of these turbocharged engines. Much has been done in design improvements to reduce thermal stresses and improve heat transfer. In addition, aftercooling of the air serves to maintain a conservative thermal load for the unit. Both variable-speed and altitude performance have been demonstrated satisfactorily in actual field performance, and these in turn, testify to the inherent advantages of the uniflow-blowdown system of turbocharging enumerated in this paper.

Development of a Lightweight, High-Output Four-Cycle Diesel Engine for Naval Service.....58—OGP-2

By L. Wechsler, Bureau of Ships, Navy Department, Washington, D. C.; and H. Holler, Mem. ASME, Nordberg Manufacturing Company, Milwaukee, Wis. 1958 ASME Oil and Gas Power Conference paper (multilithographed; available to March 1, 1959).

The development of a new lightweight high-output diesel engine for the U. S. Navy is described in this paper. The development of the engine was a joint effort in which the Navy outlined the objectives, provided consulting services, supplied funds; and the engine builder designed, built, and tested the engine.

A list of the general and detailed requirements of the new 11-in. bore × 12-in. stroke, 16 cylinder, four-cycle diesel engine rated at 3600 bhp at 900 rpm is presented.

The selection of the 11-in. bore and 12-in. stroke was predicated on the following considerations: (*a*) Engine weight; (*b*) engine height and width; (*c*) bore of adequate size to accommodate two-valve arrangement without excessive overlapping.

Details of engine component design and development include discussion of the frame, cylinder, crankshaft, connecting rod, main and crankpin bearings, piston development, cylinder head and valves, valve gear, camshaft and cams, fuel injector, turbocharger, and reverse mechanism.

Arctic Lubrication of Diesel Engines.....58—OGP-1

By E. J. Beck, Jr., Mem. ASME, U. S. Naval Civil Engineering Research and Evaluation Laboratory, Port Hueneme, Calif. 1958 ASME Oil and Gas Power Conference paper (multilithographed; available to March 1, 1959).

A review is given of lubrication problems encountered in reciprocating internal-combustion engines required to operate in temperatures below −35 F.

Satisfactory lubricants for pressure-gun greasing, transmissions, and hydraulic systems have been developed for −65 F, and allow servicing and operation at that temperature.

Crankcase-lubrication problems, on the other hand, are not near solution. Diesel-powered equipment presents other problems. Each of these areas is discussed briefly.

A series of tests are described. Tests were run with a large variety of lubricants in the full spectrum of equipment, from light spark-ignited engines in runabout equipment to the heaviest duty sled trains in diesel tractors.

The use of arctic oils has led to cranking and starting difficulties not consistent with the thought that low viscosity should solve most problems.

Investigations led to the hypothesis that, failing the development of such superior, lightweight lubricants that cranking resistance will be nominal at the starting temperature, the use of crankcase charges of relatively high viscosities for heavily loaded engines seems mandatory.

The ideal characteristics of a hitherto unavailable low-temperature oil, "golden oil," are outlined.

Performance of Economy Diesel Fuels in a Railroad Locomotive-Type Diesel Engine...58—OGP-14

By T. A. Kramer and D. P. Osterhout, Jr., Assoc. Mem. ASME, Socony Mobil Oil Company, Inc., Paulsboro, N. J. 1958 ASME Oil and Gas Power Conference paper (multilithographed; available to March 1, 1959).

Combustion studies were made in a laboratory two-stroke locomotive-type diesel engine on a number of economy fuels varying in cetane number, composition, and refining source. Operation was satisfactory on all fuels tested. Somewhat greater power was developed at standard engine settings with the economy fuels by changing the standard basic injection timing. However, the

combination of fuel-rack setting and injection timing for optimum fuel economy was different for each fuel. Predictions of performance based on physical properties of fuels alone are likely to be misleading as indicated by the data on several fuels.

The U. S. Naval Engineering Experiment Station's Part in the Development of a Diesel Engine for the U. S. Navy.....58—OGP-8

By A. C. Cavileer, U. S. Naval Engineering Experiment Station, Annapolis, Md. 1958 ASME Oil and Gas Power Conference paper (multilithographed; available to March 1, 1959).

Proof of the worth of naval machinery is its performance over a long period of time during actual fleet operation. Under present conditions laboratory testing is the only feasible means of accumulating sufficient data. This paper describes the efforts of the U. S. Naval Engineering Experiment Station, in co-operation with the Bureau of Ships and the contractor, to evaluate the new diesel engine through laboratory testing.

Descriptions are given of the complete facility for the testing of the engine. The test program at the Station has required the engine to operate at a normal shipboard full-load rating of 1335 hp at 1335 rpm. Evaluation tests are performed to determine the engine's capabilities and limitations, fuel and lubricating-oil consumption rates, and, in general, its operation under simulated conditions.

Reliability and development tests are performed to determine the effects of long-time operation. This involves the normal wear, excessive wear, and breakage of parts, and includes the development and tests of new parts to correct the difficulties and to improve the engine.

The Contractor's Part in the Development of a Diesel Engine for the U. S. Navy.....58—OGP-6

By A. K. Antonsen, Mem. ASME, Fairbanks, Morse & Company, Beloit, Wis. 1958 ASME Oil and Gas Power Conference paper (multilithographed; available to March 1, 1959).

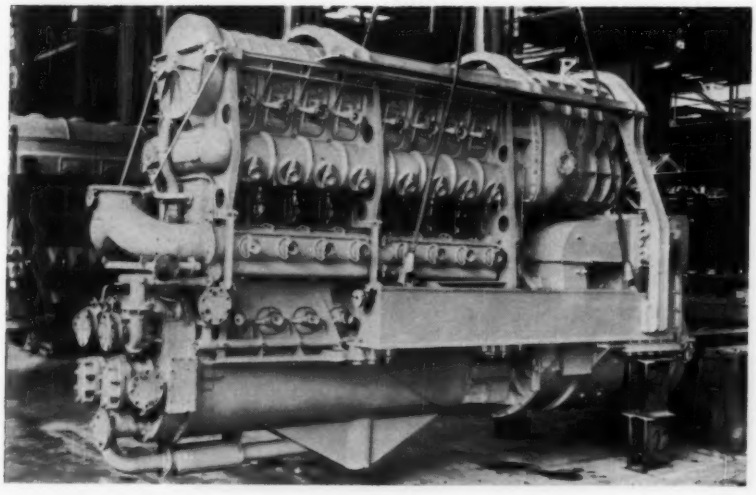
The builder of a new lightweight engine for the Navy is Fairbanks, Morse & Company. This paper reports their experience in operation and the remedies applied to correct deficiencies in the engine.

In line with established practice, this engine was to be of the opposed-piston type with two crankshafts relatively timed by means of a train of gears. The space requirement established a maximum stroke as well as a maximum bore. The weight requirement further limited the stroke-to-bore ratio.

New and improved features which were introduced in order to meet specified requirements are presented. The cylinder block, exhaust manifolds, crankshafts, cylinder liners, connecting rods, piston, and crankshaft main drive are treated in detail.

The engine-direct-driven auxiliaries—the engine blower, sea-water and freshwater pumps, and such—and safety devices are also discussed.

Opposed-piston-type diesel engine Fairbanks-Morse Model 38A6$^{3}/_{4}$ air-receiver side. Engine was developed with the co-operation of the builder, the Bureau of Ships, and the Naval Engineering Experiment Station. (58—OGP-9)



The Bureau of Ships' Part in the Development of a Diesel Engine for the U. S. Navy.....58—OGP-9

By J. H. Reinertson, Mem. ASME, Bureau of Ships, Department of the Navy, Washington, D. C. 1958 ASME Oil and Gas Power Conference paper (multilithographed; available to March 1, 1959).

The U. S. Navy, Bureau of Ships, in direct co-operation with the Naval Engineering Experiment Station and the builder, has been working on the development of a new lightweight-diesel engine since the end of World War II.

The new engine, an opposed-piston engine, is rated at 1500 hp at 1500 rpm. One of its unusual features is the bolting of the generator directly to the engine frame. By the elimination of the need for an engine subbase, a considerable weight saving is effected.

In the period since 1955 considerable operating experience has been obtained with this engine. Many of the engine parts have required redesigning and a considerable amount of information has been obtained.

An outline of the Bureau of Ships' participation in this program is presented.

Some of the special requirements of the engine are noted. Procurement action and its attendant problems are the Bureau's responsibility and are considered. Also included in a discussion of the service problems encountered in the engine are vibration, cylinder liners, pistons, and so on. Problems with instrumentation are also noted.

Lubrication of Large Diesel Cylinders..... 58—OGP-3

By J. E. Cox, Shell Oil Company, New York, N. Y.; and P. D. Hobson, Shell Oil Company, Martinez, Calif. 1958 ASME Oil and Gas Power Conference paper (multilithographed; available to March 1, 1959).

A progress report on the development of suitable lubricants for large diesel cylinders is presented. Particular emphasis has been placed on the problems encountered and measures taken when heavy residual fuels are burned in large diesel engines. Results of field trials using radioactive tracers to map the route and extent of combustion-product contamination are discussed. From early knowledge acquired about the mechanism of wear and contamination in large diesel engines, the orderly development of a lubricant specifically for this service was undertaken in the laboratory. A highly basic emulsion lubricant was developed which gave outstanding performance. Field trials and subsequent commercial application have confirmed laboratory predictions which suggested that this development represented a major event in big diesel-lubrication history.

The paper contains data obtained from a representative number of crosshead-type as well as trunk-piston-type engines in which the emulsion lubricant has been applied. This work points out the outstanding wear reduction and improved cylinder cleanliness obtained with this lubricant. Also discussed is the continuing effort to improve lubricants used in trunk-piston-type engines both with and without separate cylinder-lubrication systems. An experimental lubricant of the single-phase nonemulsion type also is discussed.

A New Look at Diesel Lubrication.....58—OGP-13

By J. V. Kalb and S. M. Pier, The Texas Company, Beacon, N. Y. 1958 ASME Oil and Gas Power Conference paper (multilithographed; available to March 1, 1959).

In an internal-combustion-engine application lubricants are required to satisfy a number of functions. Considered in this paper are two such functions:

1 To protect against corrosion of engine parts.

2 To keep the system free of deposits.

The modern internal-combustion engine must be viewed as a chemical factor of enormous complexity, the operation of which must be considered in designing lubricants for proper performance.

Current diesel-lubrication studies have resulted in the formulation of special oils specifically intended for lubricating pistons and cylinders of large marine and stationary diesel engines burning heavy fuels. The use of such oils measurably extends the useful life of piston rings and cylinder liners, and improves the economy of engine operation on heavy fuels.

Machine Design

Integration of Mechanical and Electrical Design in Servo Systems .....58—MD-12

By G. G. Ertell, General Electric Company, Waynesboro, Va. 1958 ASME Design Engineering Conference paper (multilithographed; available to Feb. 1, 1959).

Each element in a servo loop shares the responsibility for successful performance of a system. Deficiencies of one component can often be offset by modifying another component in the loop. Systems made up of electrical, mechanical, and hydraulic elements require particular attention to integration during design to give maximum practical performance at minimum expense.

Selection of the components to make up the servo loop can be based on such factors as: (*a*) Process to be performed; (*b*) type of operation; (*c*) method of motion; (*d*) characteristics of the elements; (*e*) physical arrangement; and (*f*) environment.

Integration of design requires the consideration of these factors in a logical procedure. For example, the function of the system is defined, selection of parts for characteristics desired or available, then compromises made to arrive at the best mechanical-electrical servo system.

Data are given and examples shown which take into account these and other problems, and the solutions necessary to have an integrated servo system.

Mechanical Memory Devices..... .....58—MD-1

By Arthur Mirel, American Machine & Foundry Company, Greenwich, Conn. 1958 ASME Design Engineering Conference paper (multilithographed; available to Feb. 1, 1959).

A mechanical memory device is usually an arrangement of mechanical components designed to perform a repetitive pattern of useful motion. The motion may be derived from external intelligence or a programmed time sequence incorporated into the design of a mechanism.

Criteria to determine mechanical memory must satisfy three basic elements: (*a*) Input or sensing intelligence; (*b*) selection of a particular element in time; and (*c*) the mechanical translation.

Examples of mechanical components having basic memory characteristics are banked cams, hydraulic barrel or sleeve valves, interlocks, limit switches, and others.

It is often necessary to develop ingenious mechanical devices that fall outside the category of "standard" components. However, the standard devices must be examined and understood. Some standard mechanical memory devices are cams, totalizers, memory wheels, sorters, master plates, and chain-lug arrangements. More complex devices include multielement electromechanical and electrohydraulic concepts.

In any comparison of mechanical memory components to all-electronic systems, it should be realized that electronic systems store a greater variety of intelligence and have a faster response. However, complex circuitry is involved. On the other hand, mechanical systems have kinematic problems at high speed, and response time.

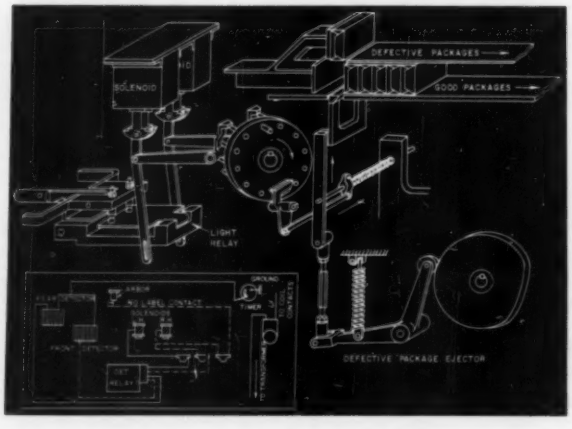
The paper gives examples of the various mechanical memory devices and establishes criteria for the various principles.

Effect of Rate on Tensile Properties of Plastics.....58—MD-3

By G. R. Rugger, E. McAbee, and M. Chmura, Picatinny Arsenal, Dover, N. J. 1958 ASME Design Engineering Conference paper (multilithographed; available to Feb. 1, 1959).

Because of inherent properties, plastics are being used more and more. Such properties as lightweight, low thermal conductivity, high specific heats, and electrical resistivity require their use, not as substitutes, but because they are the only materials that can do the job.

Plastics are rate sensitive and to design items or predict performance at very high rates of loading is impossible when only



Automatic defective-package ejector is part of AMF cigarette-packaging machine which employs a mechanical-memory device (58—MD-1)

data obtained at low rates of loading are available.

When the importance of the change in properties with rate of load application was realized, many attempts were made to extrapolate from low-rate data or substitute the effect of temperature for the effect of rate.

This paper presents high-rate data by the actual performance of tests in the 5–15 milliseconds to fracture range. Discussed are the results of these tests on five plastics: Cellulose acetate, cellulose nitrate, nylon, polystyrene, and polyethylene. A table gives low and high-rate values of yield strength, tensile strength, elongation, and modulus. The paper contains similar data on about 20 more materials.

Problems in Automatic Machinery .....58—MD-7

By M. J. Faltot, New Jersey Machine Corporation, Hoboken, N. J. 1958 ASME Design Engineering Conference paper (multilithographed; available to Feb. 1, 1959).

An analytic approach to problems encountered in straight-line, rotary, and a combination of straight-line and rotary automatic machines is presented.

Conveying systems of the belt or chain type are discussed and two types of cut-off mechanisms are noted.

An index mechanism, a mechanism that indicates the presence of a part to be worked, is also treated.

Orientation mechanisms for odd-shaped parts are considered.

Pressure mechanisms and intermittent motion mechanisms are also included.

Applications of these mechanisms are given in some detail, and an example of a bottle-labeling machine is presented.

Current Design Practices in Electrohydraulic Control Systems for Airborne Aircraft and Ground Applications.....58—MD-6

By F. L. Moncher and L. D. Taylor, Vickers, Inc., Detroit, Mich. 1958 ASME Design Engineering Conference paper (multilithographed; available to Feb. 1, 1959).

The increased performance requirements of high-speed aircraft and missiles have put mounting responsibility on the system designer to have a current knowledge of technological advancements in the control field. Electrohydraulic control systems meet these performance requirements because of their inherent small inertia, high speed, low time constant, and high power gain characteristics. To use hydraulic control systems to their best advantage, the designer must have a knowledge of some fundamental hydraulic servo-design considerations. A description of basic control systems and typical applications is presented in this paper along with a review of hydraulic-design considerations.

Electrohydraulic Applications to Machine Tools.....58—MD-5

By A. H. Dall, Mem. ASME, and E. J. Rivoira, Assoc. Mem. ASME, The Cincinnati Milling Machine Company, Cincinnati, Ohio. 1958 ASME Design Engineering Conference paper (multilithographed; available to Feb. 1, 1959).

Electrohydraulic drive systems for machine tools are becoming increasingly popular. An analysis is presented of the needs of such systems as their size, speed, and accuracy are changed to meet the demands of economical production. Specially developed components are discussed in terms of the requirements of proportional machine-tool servo systems. The contributions of these components are presented in transfer functions representative of an electrohydraulic servo system. The results of their application to the solution of specific production problems are then presented.

A Central Catalog File Saves Engineering Time and Money.....58—MD-14

By J. L. Dykes, E. I. du Pont de Nemours & Co., Inc., Wilmington, Del. 1958 ASME Design Engineering Conference paper (multilithographed; available to Feb. 1, 1959).

A real need exists for central catalog files in both large and small companies. They are time savers as well as money savers. Technically trained personnel can find the material they need in a minimum amount of time which indirectly saves money since less time is involved in searching and waiting for specific or general catalogs.

Vendors appear to like central files. They know their information is located for all to use, but more important it is kept up-to-date. A minimum of expensive catalogs is dispersed and visibility of the product is high.

A survey of engineering personnel in one concern showed a saving of 22.5 minutes, or $^1/_3$ of an engineer man-hour, per referral since a central file system was installed. Included in the survey were other questions that indicated prior to the central file, catalog data was obtained by letter or telephone, and that often files were borrowed without knowing if they were current.

One engineering department catalog file has expanded to six locations; includes 12,000 catalogs, and has increased from 1600 monthly referrals in 1954 to 5000 at present.

The paper discusses the need for engineering catalogs, advantages and disadvantages of a central catalog file, methods of creating a central file, operation and cost of central catalog file.

The Information Center of Tomorrow.....58—MD-13

By Allen Kent and J. W. Perry, Western Reserve University, Cleveland, Ohio. 1958 ASME Design Engineering Conference paper (multilithographed; available to Feb. 1, 1959).

The development of science and technology has generated an unprecedented flood of new knowledge. Its technological application has become more and more difficult as traditional library tools for facilitating the availability of recorded knowledge have suffered a serious decline in effectiveness.

Various improved methods and new devices for the analysis, storage, selection, and retrieval of information have to be developed or adapted for improving the effective availability of recorded knowledge. Use of computerlike devices for searching and correlating scientific and technical literature has pointed the way to centralization of processing of information for automatic search. The searching and selecting operation may be performed either centrally or on the premises of individual organization if equipment is available.

Documentation in engineering and scientific fields will require a group of techniques to give maximum accessibility and utility to the information contained. Group of techniques may be subdivided as:

1 Generation of manuscripts by authors or similar preparation of the originals of other documents.

2 Distribution of complete documents or abstracts to provide awareness of recent developments.

3 Storage in conjunction with processing to facilitate subsequent re-use.

4 Retrieval of documents from storage to provide information needed.

Major problem is in the retrieval of documents. Document retrieval depends on the skill in the selection of important characteristics of subject matter and also in depth of analysis as to detail; and in the tools used for search and correlation.

An engineering approach to documentation requires that attention be devoted to: (*a*) Purposes to be served; (*b*) process involved; (*c*) underlying theory of such processes; (*d*) method of measuring degree of effectiveness obtained; (*e*) development of means for counteracting imperfections in available means; and (*f*) establishing relationships between

costs of various operations and benefits provided.

Methods are discussed and examples shown of present and proposed means of storing and retrieving engineering and scientific information.

Lubricant Considerations in Centralized Systems.....58—MD-8

By R. D. Skoglund, Assoc. Mem. ASME, and R. K. Gould, Texaco Research Center, Beacon, N. Y. 1958 ASME Design Engineering Conference paper (multilithographed; available to Feb. 1, 1959).

Satisfactory operation of modern machines depends not only on the correct lubricant, but also, on the proper amount applied at the proper time. Modern machines require devices for lubricant application which are as independent as possible of the human element.

Many varieties and types of equipment are available for applying industrial lubricants, ranging from devices to lubricate a single bearing to fully automatic central systems capable of lubricating all of the machinery in a plant. Each of these satisfies a need and occupies a definite niche in the general field of lubrication.

The selection of suitable lubricants for central systems involves consideration of several factors. A discussion of these factors with particular emphasis on grease pumpability characteristics is presented in this paper.

Laboratory data are shown for various bench tests that have been used to obtain predicted performance results for greases in centralized systems.

Integrating Mechanical and Electrical Design in Servo Systems.....58—MD-11

By W. L. McCann, Mem. ASME, Giddings & Lewis Machine Tool Company, Fond du Lac, Wis. 1958 ASME Design Engineering Conference paper (multilithographed; available to Feb. 1, 1959).

Servo-controlled drives must be capable of almost instantaneous response to the controlling signal. Sources that might change or vary the drive response must be considered and compensated for in the mechanical or electrical system.

In a servo-controlling machine, rigidity between the servomotor and the driven mechanical component is mandatory. For example, any change in the signal input of the servo to the actuator, whether it is a hydraulic cylinder, hydraulic motor, or an electric motor must result in motion of the controlled components.

Also, stiffness of the machine frame members is important, but must be balanced against mass if the component is a moving member. Here, proper distribution of metal is important because natural frequency of frame members is a contributing factor in the machine's freedom of vibration under outside loads.

Compromises must be made in mechanical and electrical design to balance the effects of desired machine characteristics. For example, to reduce deflections contributing to backlash, lower friction forces are desirable which will reduce the forces required to move the component, but this will reduce the damping effect of vibrations. A certain amount of friction may be desirable, and a balance can be obtained by increasing the stiffness of the servo drive, allowing the servo to absorb the energy of vibration. To stiffen the drive, larger diameter components will be necessary and this will increase the inertia.

Hence compromises must be made to obtain optimum results. Methods of arriving at and defining the balance needed between the mechanical and electrical systems are explained and illustrated.

Compatibility of Metals in Bearing Contact.....58—MD-9

By C. L. Goodzeit, Assoc. Mem. ASME, General Motors Research Center, Detroit, Mich. 1958 ASME Design Engineering Conference paper (multilithographed; available to Feb. 1, 1959).

Journal bearings usually operate with hydrodynamic lubrication, in which case a thin fluid film separates the moving surfaces of the bearing and journal. Under these conditions, the performance of the bearing is virtually independent of the choice of material. However, when the journal starts and stops under load or the bearing suffers from insufficient lubrication, the surfaces actually contact and slide together under conditions of boundary lubrication. Seizure occurs with a poor choice of materials while good materials survive.

Antiseizure properties govern the material choice of a journal-bearing combination. After this requirement is satisfied, the bearing material is selected for its resistance to fatigue from dynamic loads, corrosion resistance, and toleration to dirt, if present, in the lubricant. Other factors, such as operating temperature, geometrical configuration, manufacturing technique, and design are equally important in the final choice.

The bearing metal theory permits two general rules to be made about the antiseizure properties of alloys.

1 Seizure resistance of a good bearing metal cannot be sensibly improved by the addition of alloying agents. A metal resists seizure with the journal by virtue of its immiscibility and difference in bond type; once established, alloying cannot improve the metal resistance to seizure. Alloying may reduce the seizure resistance of a good bearing metal.

2 Metals having poor antiseizure properties can often be improved through alloying. Improvement comes about in two ways. One, alloying a pure metal generally increases its hardness and strength. Two, alloying with a metal having good antiseizure properties. The stronger metal supports the load and the good bearing metal can smear over the surface and provide seizure resistance.

Other factors play an important role in the final selection; however, the bearing metal theory points the direction toward the choice of materials for new applications and improved performance of existing bearings. All these factors are discussed and examples given of bearing selection using the bearing metal theory as a basis.

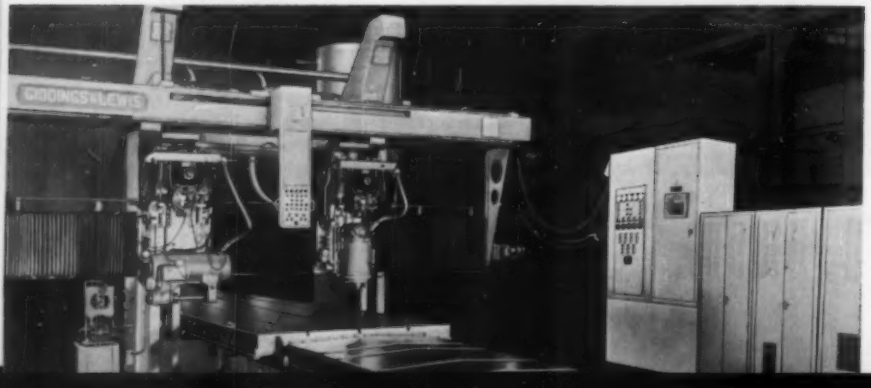
High-Strength Structural Sandwich Construction.....58—MD-10

By W. E. Dirkes, Assoc. Mem. ASME, USAF, Wright Air Development Center, Ohio. 1958 ASME Design Engineering Conference paper (multilithographed; available to Feb. 1, 1959).

Composite materials have found increasing use because material configurations can be adjusted to use the desirable properties of each material. Sandwich construction is a type of composite material; the components of a sandwich panel also may be composite materials.

Principal benefit of sandwich construction gives a greater section modulus per unit of density than a conventional beam or panel of solid material. Also, maximum moment developed is resisted by high tensile stress and high compressive stress in the faces.

Skin-milling machine in which servo controls are employed on table and crossheads (58—MD-11)



Almost any structural sheet material can be used for sandwich faces, and almost any lightweight material can be used for the core. The specific materials selected depend upon the requirements of a particular design. Functionally, since core material is used to hold the faces apart to increase the section modulus, the core must give either sufficient support to restrain the faces from buckling, or the sheet material and thickness must be selected to resist buckling. The bond between faces and core, of course, must have sufficient strength to hold the materials together under all required load conditions.

In selecting components for sandwich construction, major consideration must be given to the core, faces, and joining medium to assure the meeting of design criteria, fabrication techniques, and proposed application.

Aviation

Criteria for Local Airline Equipment.....58—AV-30

By B. J. Herkimer, Aviation Financial Services, Inc., New York, N. Y. 1958 ASME-ARS Joint Aviation Conference paper (multilithographed; available to Jan. 1, 1959).

Financial aspects of the local airline equipment problem are noted. The local airline industry is a relatively new industry and is heavily dependent upon government subsidy.

These airlines are operating with obsolete, unpressurized, uneconomical equipment. The limited revenues obtainable with the equipment they are operating, plus a high percentage of unprofitable route structure, and a relatively inflexible operation prevent profitable operation. Without earning it is exceedingly difficult to attract new capital which is necessary to improve operations.

The local airline industry despite the many financial problems which hamper it, is currently faced with re-equipping. For the local airlines to hold their present passengers and expand their passenger revenues they must offer conveniences and comforts comparable to those on the trunk lines.

The Fairchild F-27 is an example of the type of equipment which will help the local airlines out of their deficits.

Criteria are presented which will be the basis for dollar advances to the industry for their re-equipment programs.

Operations Planning for Introducing New Aircraft Into a Local Service Airline System.....58—AV-12

By T. H. Davis, Piedmont Airlines, Winston-Salem, N. C. 1958 ASME-ARS Joint Aviation Conference paper (multilithographed; available to Jan. 1, 1959).

One of the problems confronting the local service airline industry was the lack of a modern, efficient airplane designed specifically for short-haul operation. Within the next few months, such an airplane will be available.

The first airplane to be built in the United States in response to the requirements of the local service airlines is the Fairchild F-27. The F-27 was designed by the Fokker Aircraft Company, Holland, and the first prototype was flown in November, 1955.

The most notable feature of the F-27 is the Rolls-Royce Dart engine. For passenger comfort the F-27 is pressurized and air conditioned. It has a high wing configuration which facilitates loading and makes it possible for passengers to enjoy an unobstructed view from any seat in the airplane. The plane will seat 40 passengers and cruise at 280 mph.

An outline of the planning and training program employed by Piedmont Airlines prior to operation of the F-27 is given. The basic program consists of two major categories—personnel training and equipment procurement. Personnel training is further separated into four groups: Flight personnel, aircraft and engine mechanics, communication and electronic mechanics, and station servicing personnel.

The Allison 501-D13 Prop-Jet Engine and Its Place in the Air-Transport Industry.....58—AV-27

By J. D. Beaumont, General Motors Corporation, Indianapolis, Ind. 1958 ASME-ARS Joint Aviation Conference paper (multilithographed; available to Jan. 1, 1959).

The Allison Model 501-D13 is a prop-jet engine. The reduction gear box is secured to the power section by the torque shaft housing and two struts. The gear box contains two stages of gear reduction, a spur gear set, and a planetary system. Over-all reduction is 13.54 to 1 which results in a propeller speed of 1020 rpm when the engine is running at normal speed, 13,820 rpm.

The power section consists of the compressor, combustion section, and turbine assemblies plus the various engine controls and accessories.

A description of the Allison Model 501 engine, its place in the air transport industry, and a typical application of the engine in the Allison Convair 340/440 conversion are presented.

The descriptive section includes details on operating principles, the control system, and safety features.

The place of the prop-jet engine in the airline industry is examined by comparing direct operating costs of a prop-jet and a straight-jet airplane, both designed to do the same short-to-medium range job. The section on the Allison Convair 340/-440 conversion points up the important improvements in performance and passenger appeal which can be obtained by converting existing Convair airplanes to Allison 501 prop-jet power.

Introduction of New Transport Designs.....58—AV-19

By W. J. Mitchell, Bonanza Air Lines, Las Vegas, Nev. 1958 ASME-ARS Joint Aviation Conference paper (multilithographed; available to Jan. 1, 1959).

With its speed, superb single-engine performance, unsurpassed cabin comfort, and operating economy, the F-27 will set new standards of service in the rapidly expanding field of dependable short-to-medium-haul air transportation of the type provided by local-service airlines.

A combination of four major developments has enabled these airlines to move into this brighter, more promising future. These developments are:

1 The arrival, as a tangible production item, of the first new modern equipment designed for specialized services.

2 The signing into law of an equipment guarantee loan bill, sponsored by the Civil Aeronautics Board, to facilitate the financing of new aircraft.

3 The continuing CAB policy of encouraging the growth of local lines by strengthening their route structures, whenever possible.

4 The ever-increasing awareness, among military, civil, and business leaders, of the energizing role played by local lines in bringing the benefits of the air age especially to the smaller and medium-sized community—benefits which range from decentralization of industry to additional revenues from tourism.

Mechanical-Engineering Aspects of the High-Speed-Aircraft Escape-System Problem.....58—AV-7

By C. W. Russell, Republic Aviation Corporation, Farmingdale, N. Y. 1958 ASME-ARS Joint Aviation Conference paper (multilithographed; available to Jan. 1, 1959).

The mechanical engineer's concern in escape-system design includes four general areas: General problems, problems pertaining to structure, problems involving aerodynamics, and problems involving mechanical design.

The general requirement for an escape system is to allow the pilot to separate and descend safely from the aircraft

throughout the entire operational altitude and speed range of the airplane.

There are four basic types of pilot capsules: (*a*) Cockpit capsule, a recessed type which includes all the cockpit equipment such as console, flight controls, instrument panels, and so on; (*b*) nose-type cockpit capsule—similar in equipment requirements to the recessed type, but designed to provide escape by separating the front end of the aircraft from the rear portion; (*c*) the seat-type capsule which is a minimum size enclosure providing the minimum of space required to house the pilot and seat; and (*d*) a compromised version which houses pilot, seat, and possibly flight controls, but not the consoles or instrument panels.

Mechanical design requirements of the various systems of a capsule are discussed in detail and in the sequence of their operation during an escape. The rail system and flight controls, however, are considered first since they are affected by the ingress and egress problem. Ventral fins, door actuation, the pilot's harness, the window mechanism, capsule uplocks, catapult mechanism, dorsal fins, parachute operation, and shock absorption are treated. These gadgets and systems serve as examples of the complexity of design of one capsule escape system.

It is emphasized that there is no margin for error in the mechanisms utilized in this or any escape device.

Mechanical Design in Aircraft.....58—AV-1

By H. E. Cornish, Douglas Aircraft Company, Inc., El Segundo, Calif. 1958 ASME-ARS Joint Aviation Conference paper (multilithographed; available to Jan. 1, 1959).

The mechanical engineer's efforts are applicable to approximately half of the airplane's weight empty. A discussion is presented of design philosophy in terms of reliability, growth factor, design exactly to satisfy a specific need, maximum technical quality, materials, and cost.

Further discussion is presented on general design considerations. A general description is given of several of the more critical mechanical installations in the aircraft—the A3D nose landing gear, main landing gear, and arresting-gear installation.

Philosophy and Mechanization of an Air-Data Computer..58—AV-15

By J. H. Andresen, Jr., Andresen Associates, Greenwood Lake, N. Y.; and H. F. Colvin, III, Air Data Instruments Corporation, Elmhurst, N. Y. 1958 ASME-ARS Joint Aviation Conference paper (multilithographed; available to Jan. 1, 1959).

Air data, in general, are those parameters of aircraft condition or performance which can be derived from measurements made on the air through which the aircraft is flying. In practice, these measurements are static pressure, stagnation pressure, air temperature, and airflow direction. The flight parameters derived from these measurements include altitude, vertical speed, airspeed, Mach number, corrected air temperature, air density, and corrected angle of attack.

Gradually, the concept has spread of a centralized source of much or all of these data, which would eliminate the need for duplication of computing facilities. This centralized source has become known as a "central air-data computer."

The need and general characteristics of an air-data computer are discussed. Areas where further study of air-data computers is required are noted.

On the Measurement of High-Temperature Radiation Properties of Solids.....58—AV-29

By P. E. Glaser, Mem. ASME, and H. H. Blau, Jr., Arthur D. Little, Inc., Cambridge, Mass. 1958 ASME-ARS Joint Aviation Conference paper (multilithographed; to be published in *Trans. ASME;* available to Jan. 1, 1959).

To meet the demands of modern technology, engineers must extend their understanding of the behavior of materials to conditions existing at high temperatures. Although sufficient information has been accumulated on various material properties in the range from 100 to 1500 K, a great deal of physical data on the behavior of materials at high temperatures remains to be gathered. Such data will lead to improved designs for gas turbines, rocket motors, missile systems, and nuclear applications, and will establish criteria for material that will ultimately be used for thermal nuclear-power developments.

In the study of heat-transfer mechanisms, the emissivity of a material is of particular concern since heat transfer by radiation, often the dominating term at high temperatures, is dependent on this physical property. Measurement of either total or spectral emissivity at high temperatures does not differ in principle from low-temperature measurement. However, since it is difficult to attain the required high temperature and at the same time measure only radiation emitted by the sample material, new techniques must be employed. This paper describes a system used to measure the spectral emissivity of solid materials at temperatures as high as 3500 K.

The advantages of using a solar furnace for this application are pointed out and the necessary optical system described. The function of the shutter for separating emitted and incident radiation, control of the temperature by the aperture limiting cylinder, and the calibration of the monochromator by a black-body reference standard, are explained.

Studies in Aircraft Maintenance Productivity Analysis..58—AV-24

By I. J. Kessler, DCS/O Hq USAF, Washington, D. C. 1958 ASME-ARS Joint Aviation Conference paper (multilithographed; available to Jan. 1, 1959).

Aircraft maintenance absorbs 33 per cent of the Air Force personnel and 40 per cent of its operating budget. The rate of flying of a craft is automatically limited by the rate of maintenance that can be provided for that craft.

Operations analysis—the use of scientific methods to analyze difficult operational problems—has been used to study aircraft maintenance.

The following aspects are discussed:

1 A simple measurement of the advance of the state of the art of maintenance.

2 Measuring the development of aircraft and their components under the repair-and-replace concept of maintenance.

3 Measuring aircraft reliability development on the basis of the predictable-unpredictable workload relationship.

4 An approach to the evaluation of the disposal-at-failure concept of maintenance.

Local-Service Airlines and the Jet-Engine Overhaul Problem.....58—AV-25

By J. E. Lockhart and A. Hartung, Southwest Airmotive Company, Dallas, Texas. 1958 ASME-ARS Joint Aviation Conference paper (multilithographed; available to Jan. 1, 1959).

"Why should a commercial airline contract for overhaul of its turbine engines—and how can it depend on the servicing company for best results?" These are the questions answered in this paper. Through a description of early overhaul ventures, a record of accomplishment, and a discussion of quality control, the questions are answered in part. A comparison of facility costs, amortization, and direct labor costs completes the picture.

Airframe Design for Local Airlines Operation.....58—AV-13

By W. H. Arata, Jr., Fairchild Engine & Airplane Corporation, Hagerstown, Md. 1958 ASME-ARS Joint Aviation Conference paper (multilithographed; available to Jan. 1, 1959).

A successful airplane will normally be

one that has been tailored for a specific job and satisfies the major needs of the user.

The aircraft manufacturer catering to local airlines must recognize that their problems are somewhat unique in the transportation industry, and close attention must be given to the design in order that a usable airplane results.

Airframe-design considerations for a local airline operation are presented and, when applicable, the Fairchild F-27 is used as an illustration. The requirements are given for a design that will incorporate passenger appeal, superior in-flight operation, and ease of ground operation—handling, replenishing, loading, towing, and systems.

Metallurgical Factors in the Design of Hydraulic Equipment for Elevated Temperature Application.... .....58—AV-11

By A. Mars, Vickers Incorporated, and N. M. Lazar, Wayne State University, Detroit, Mich. 1958 ASME-ARS Joint Aviation Conference paper (multilithographed; available to Jan. 1, 1959).

The selection of the proper metallic materials is one of the more difficult problems faced by designers of high-temperature hydraulic units.

The metallurgical factors controlling the use of metals for hydraulic applications in the temperature range of 400 to 900 F are discussed. The materials available were appraised and some of the service experiences were related.

It appears that a number of materials will be satisfactory for these applications. For highly stressed and wear parts, tool-steel-grade steels show promise. The cast irons show satisfactory structural stability in the foregoing temperature range for some wear applications and for structural parts and bodies. The nonferrous alloys must be selected with great care, since the temperature range of their usefulness is limited. Recent literature indicates that some improvements are forthcoming; however, most of the data are from the early stages of investigation.

Designing and Testing for High-Temperature Hydraulics. 58—AV-6

By F. L. Moncher and L. D. Taylor, Vickers Incorporated, Detroit, Mich. 1958 ASME-ARS Joint Aviation Conference paper (multilithographed; available to Jan. 1, 1959).

Aircraft auxiliary power systems must operate at higher temperatures in modern high-speed aircraft. In a discussion of boundary-layer temperature and the thermal thicket, a review is given for the conditions which require high-temperature operation of hydraulic equipment.

The design problems involved in producing equipment for operation at high temperatures are noted. Temperature effects on metals are discussed in relation to hardness, strength, creep, wear, and the thermal coefficient of expansion.

Actual testing of complete hydraulic units and subassemblies includes five general areas: (*a*) General performance tests; (*b*) shock temperature testing; (*c*) vibration plus other ambients; (*d*) endurance tests; and (*e*) qualification testing. Each of the five is outlined.

Facilities—test stands, ovens, and chambers used for high-temperature testing are described. High-temperature hydraulics units are considered and some discussion is presented of innovations in a design of a high-temperature hydraulic pump.

Solid Lubricant Coatings..... .....58—AV-20

By L. Berry, Sandia Corporation, Albuquerque, N. Mex. 1958 ASME-ARS Joint Aviation Conference paper (multilithographed; available to Jan. 1, 1959).

Properly used, solid lubricants are superior to conventional lubricants at high loads and have, in addition, potential value at higher temperatures. Interest in solid-film lubricants was further stimulated by the fact that some components must be capable of performing after five years of static storage without relubrication. Solid lubricant coatings have been of considerable value in this area. But optimum performance can be obtained from these relatively new lubricants only if the variables affecting their performance are known and taken into account. Unfortunately, the literature on dry-film lubricants contains almost no quantitative data on these variables. Such data as are available apply to loads of 80,000 psi or above, whereas most Sandia applications are within the 25,000 to 30,000-psi range. This report describes the results obtained on a series of tests conducted in this range. Although still far from complete, the study has shown conclusively that it is possible to control the variables and to secure reproducible quantitative data.

All tests were run with one proprietary lubricant consisting of a mixture of molybdenum disulfide and graphite bonded with a thermosetting resin at a sliding velocity of about 19 fpm. Tests were made on a Falex lubricant tester, chosen because it makes it possible to vary the load and to measure torque and wear without interrupting the test. Some data were obtained on the effects of each of the following variables: Metal pretreatment, hardness, break in or burnishing, surface finish, coating one or both bearing materials, load, humidity, use with nylon bearings, retouching, and use with oil and grease.

Low-Power Engine-Component Tests.....58—AV-22

By R. L. Penrose, Mem. ASME, Westinghouse Electric Corporation, Kansas City, Mo. 1958 ASME-ARS Joint Aviation Conference paper (multilithographed; available to Jan. 1, 1959).

With emphasis on high-temperature facilities capable of simulating high-speed flight conditions, experiences with equipment required for testing jet-engine lubrication, fuel and control-systems components, and structural parts are related. For instance, operation of some control and lubrication-system parts up to 800–1000 F are mentioned. High-speed spin rig and disk testing with temperature capabilities up to 2000 F are included. High-temperature strain gages, as an example of advanced instrumentation pickups suitable for measuring strain under high flight-speed conditions, are manufactured and applied to internal jet-engine parts exposed to temperatures up to 1500 F. Safety precautions, with respect to personnel and plant, associated with high-temperature-facility operations are considered.

Variable-Incidence Wing-Operating Mechanism.....58—AV-2

By D. M. Bland, Chance Vought Aircraft, Inc., Dallas, Texas. 1958 ASME-ARS Joint Aviation Conference paper (multilithographed; available to Jan. 1, 1959).

The design of an operating mechanism for varying the angle of incidence between the wing and fuselage of an airplane while in flight is the subject of this paper. The angle of incidence is the angle the wing makes with the airplane fuselage. Certain advantages exist, particularly in naval carrier-based aircraft, from having the wing at a high angle for take-off and landing, and at a low angle for all other flight conditions. This paper deals first with these advantages and the considerations for establishing the design ground rules, and then with actual mechanism designs for providing the two desirable wing flight positions.

Cabin Cooling for the Douglas Jet Transport.....58—AV-23

By R. N. Krueger, Douglas Aircraft Company, Santa Monica, Calif. 1958 ASME-ARS Joint Aviation Conference paper (multilithographed; available to Jan. 1, 1959).

In designing the cooling system for the Douglas DC-8 jet transport, the objective was to obtain a system which would provide the necessary comfort while

maintaining the greatest reliability with the minimum penalty to airplane performance.

Experience with the DC-7 had shown that a vapor-type cooling system held several advantages over an air-cycle system if the weight of the vapor-cycle system could be made comparable. Investigations showed that if vapor-cycle cooling was to be used for the DC-8, the total weight of the components necessary to provide 27 tons of cooling would have to be less than 300 lb.

Two vapor-cooling systems of equal capacity are used to provide cooling for the cabin and cockpit, each consisting of an evaporator, condenser, condenser fan, receiver, compressor, expansion valve, and necessary refrigerant piping.

This paper presents the factors evaluated in establishing this cooling system for the Douglas DC-8, and the design approach used in selecting and designing the various components of this system. In addition, the paper describes the integration of the cooling system into the complete air-conditioning system.

Ball Motion and Sliding Friction in Ball Bearings.....58—AV-14

By A. B. Jones, The Fafnir Bearing Company, New Britain, Conn. 1958 ASME-ARS Joint Aviation Conference paper (multilithographed; available to Jan. 1, 1959).

In modern high-speed ball bearings the pressure areas, which result from elastic deformations at the ball-race contacts, are appreciably curved and interfacial slip can occur at most points within the pressure areas.

These slippages give rise to friction forces acting on the ball which are held in equilibrium by reactions from the races and the inertia effects of the motion of the ball. A method is derived for determining the motion of the ball and the sliding friction in a high-speed, angular-contact ball bearing under thrust load in terms of the inertia effects on the ball, and the frictional resistances resulting from interfacial slip at the contact areas. Possible elastic compliance at the interface, hysteresis, and dynamical perturbations of ball motion are neglected.

The solution of eight, simultaneous equations involving double integrals for which closed-form solutions cannot be found, is required. A solution for a particular case requires the services of a high-speed computer. For the case where gyroscopic effects on the ball can be neglected, certain simplifications and assumptions can be made which enable the solution of a particular problem using conventional computation means.

Automatic Techniques

The Application of the Punch Card to Automatic Weighing of Bulk Materials.....58—AUT-7

By W. M. Young, Richardson Scale Company, Clifton, N. J. 1958 Joint Conference on Automatic Techniques paper (multilithographed; available to Feb. 1, 1959).

The automatic control of a dynamic batch-weighing system integrates many functions, more commonly associated with automation in the machine-tool industry. They are: Power converting and actuating; sensing; regulating; communicating; programming; computing; data converting, storing, and presenting. Data storing and data presenting are the functions which directly involve the use of a punch card and similar information-storage media.

The primary considerations for an accurate weighing system are:

1 Consistent material flow rate.
2 A precise load-sensing device.
3 Precision instruments.

Weight determination, precision instruments, the method of weight control, data storing, design specifications for the punch-card reader (PCR) are noted. Advantages and disadvantages of the standard business machine card are discussed. PCR programming is considered.

Basic Gages and Gaging Considerations for Automatic Machine Control.....58—AUT-6

By J. W. Hopper, Assoc. Mem. ASME, Pratt & Whitney Company, Inc., West Hartford, Conn. 1958 Joint Conference on Automatic Techniques paper (multilithographed; available to Feb. 1, 1959).

Automatic machine control is defined arbitrarily as a condition whereby material is manufactured by a piece of machinery, with suitable equipment to measure the product while it is being manufactured and provide corrections to the machine itself to produce material within desired limits. Gages which are discussed are dimensional devices indicating diameter, length, thickness, and so on.

A part may be gaged utilizing either of two basic principles. It may be measured from a direct-reading instrument which will indicate its true size, or by a comparator-type instrument where the indication is plus or minus from the specific size.

Setting comparator gages is discussed; and it is noted that the temperature differential between the master and the work is a significant factor when setting a gage.

The two principal types of gaging media in common use today for automatic machine-control gaging are: air gaging and electromechanical gaging. Both types are illustrated.

Logical Development of the Design for Sequential Control of Chemical Batch Process.....58—AUT-5

By J. P. Laird, Assoc. Mem. ASME, E. I. du Pont de Nemours & Company, Inc., Wilmington, Del. 1958 Joint Conference on Automatic Techniques paper (multilithographed; available to Feb. 1, 1959).

Chemical manufacturing processes frequently require safety interlock circuits which warn operating personnel of undesirable conditions or automatically act to avoid an accident. Batch-type manufacturing operations require that a succession of steps be carried out one after another, and successful operation depends on taking the proper action at the proper moment in a reproducible manner. In the past there have been serious difficulties in communication among technical personnel who are concerned with these problems. Written descriptions are frequently either vague or confusing. What is needed are techniques which will aid in reading and writing of thought and reason. This paper illustrates mathematical-logic techniques based on the principles of Boolian algebra. By means of these techniques many verbal statements can be woven together to give an objective pictorial representation of what is required of a system.

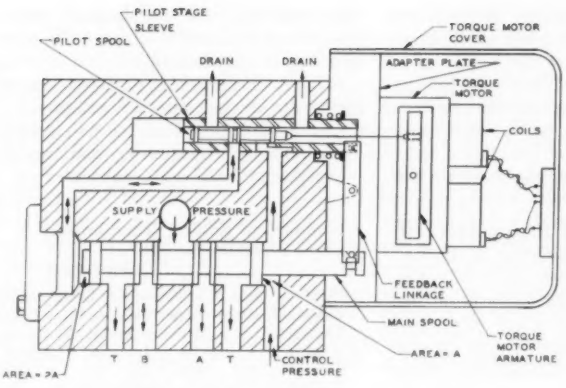
A Survey of the Application of Automatic Devices for Electric Power Generation.....58—AUT-3

By A. C. Hartranft and F. H. Light, Mem. ASME, Philadelphia Electric Company, Philadelphia, Pa. 1958 Joint Conference on Automatic Techniques (multilithographed; available to Feb. 1, 1959).

Twenty-five years ago power-plant control and load dispatching were principally manual operations. Today, automatic devices are widely used and, in many cases, essential to safe and reliable operation. Much progress has been made in automation of power-generation and distribution equipment. It is continuing. New developments include automatic data logging, automatic load control, network analysis by computers, and improved control systems. It is the purpose of this survey to describe progress made in past years and briefly discuss new developments which are indicative of future trends. With this background, we are better able to judge the merits of automation and its potential advantages.

These benefits are reduced operating costs, manpower savings, improved re-

liability, and more efficient use of manpower that has been relieved from routine duties. The potential advantages of automation increase as electric systems grow in size and complexity. Large turbine-generating units require automatic controls and protective devices for reliable operation. Interconnection of systems makes automatic control necessary for regulation of interchange power flow. An accurate evaluation of automatic control is difficult and requires careful study and judgment. Many of the advantages gained are intangible. Studies made by others provide valuable background information. This survey includes a bibliography of papers on automation in the electric power industry for the years 1950 to date.



Schematic of E-11089-4 electrohydraulic servo valve specifically designed for industrial application by Vickers, Inc. (58—AUT-2)

Applying the Electrohydraulic Servo Valve to Industry.....58—AUT-2

By Ray Spencer, Vickers, Inc., Detroit, Mich. 1958 Joint Conference on Automatic Techniques paper (multilithographed; available to Feb. 1, 1959).

The industrial control field is constantly adapting new techniques and procedures. These changes are motivated by industry's need to turn out their products faster and with greater precision. To make these improvements possible the manufacturers of mechanical, electrical, pneumatic, and hydraulic equipment are constantly developing new components and systems. Some components are developed on the basis of a general industry need and others for specific applications.

The latter group of components, though designed for specific applications, become standard components as control-system designers begin to visualize how they may be applied to other control problems. The electrohydraulic servo valve is in its transition period. The success achieved in military and machine-tool applications indicates that its potential for industrial control problems is very high. To apply the servo valve, the industrial control-system designer must become familiar with its functions, capabilities, reliability, economics, and some special considerations.

The Application of Computers to Automotive Design and System Studies.....58—AUT-1

By J. T. Olsztyn, General Motors Corporation, Detroit, Mich. 1958 Joint Conference on Automatic Techniques paper (multilithographed; available to Feb. 1, 1959).

An engineer using a desk calculator and layout methods could spend as much as 48 hr arriving at a satisfactory helical-gear set. With the aid of the computer program described in this paper, the engineer can shorten this time to a few minutes.

Part 1 covers some typical applications of a computer to problems in the area of design and system studies. The examples considered here are intended to point out: (*a*) The advantages that can be gained from the purely computational power of a computer; and (*b*) some common digital techniques which can be used to further enhance these advantages by making the computer a more versatile engineering tool.

In Part 2, a digital technique which enables the engineer to study large classes of vibration systems efficiently is discussed in some detail. Normally the study of such systems on a computer requires that the engineer first engage in a number of preparatory activities beginning with the development of an idealized structure of the vibrational system. Subsequent activities require that the behavior of the ideal structure or model be expressed analytically, that suitable numerical procedures be developed for solving the analytical expressions, and finally, that these procedures be translated into the command language of the computer. The outstanding feature of the technique presented in Part 2 is that it enables the computer itself to perform all of these subsequent activities.

Railroads

Vibration and Shock in Freight Cars as Causes of Lading Damage.....58—RR-4

By J. C. Settles, Mem. ASME, The Buckeye Steel Castings Company, Columbus, Ohio. 1958 ASME-AIEE Joint Railroad Conference paper (multilithographed; to be published in *Trans. ASME;* available to Feb. 1, 1959).

The high costs resulting from merchandise damaged in railway freight transit in recent years indicate a need for improvement and justify major changes in equipment design where necessary to meet the requirements of present operating conditions. Vibration and shock are two probable causes of lading damage. These two problems are analyzed briefly and, on the basis of the findings, methods are suggested for improving equipment design to reduce damage to both lading and equipment due to these two causes.

Available and Potential Developments in Design for Standard AAR Solid Bearing Assemblies.....58—RR-3

By M. A. Hanson, Mem. ASME, Magnus Metal Corporation, Chicago, Ill. 1958 ASME-AIEE Joint Railroad Conference paper (multilithographed; available to Feb. 1, 1959).

Examination of used journal bearings shows a substantial amount of improper weight distribution, uneven end wear, and bearing-lining deformation. Means are suggested for overcoming these deficiencies, which are contributing factors to bearing failure. The modifications of the present journal-box assembly required to allow oil seals to function are discussed, and the over-all improvement to follow is projected.

To improve further the performance of the solid-bearing assembly and to reduce the required service attention, the following action is indicated:

1 Improve the load distribution on the bearings by using adequate standards for truck overhaul.

2 Stabilize the journal-box assembly by use of journal stops.

3 More nearly equalize bearing end thrust loads by modification of the bearing design.

4 Decrease journal-box lateral by modification of the journal-bearing.

5 Reduce oil leakage by use of rear and front seals.

6 Maintain acceptable standards for journal finishing.

Although none of the changes suggested appears to be too great, if adopted, the total effect would be such as to produce a substantial improvement in performance. The over-all cost of the program would not be exorbitant and should be recovered quickly through operational savings.

The Hydracushion Car...58—RR-2

By W. K. MacCurd, Thermo Materials, Inc., Palo Alto, Calif.; and R. M. Hermes, Mem. ASME, Stanford Research Institute, Menlo Park, Calif. 1958 ASME-AIEE Joint Railroad Conference paper (multilithographed; available to Feb. 1, 1959).

The damage to lading occurring in freight cars equipped with standard friction draft gears is so well recognized that many attempts have been made to develop draft gears with softer response characteristics. In any such effort the major problem is that of dissipating the energy of impact while transmitting to the contents of the car only that portion of this energy which is necessary to accelerate such contents smoothly to the final speed of the car underframe. In the Hydracushion car a hydraulic buffer has been combined with a sliding-sill cushion-type underframe to control the flux of energy to the car lading.

It is the object of this paper to outline briefly the unique constructional features of the Hydracushion car and to report manufacturing, operating, and maintenance experience with such cars.

Aluminum in Rolling Stock Impact Tests at Collision Speeds.....58—RR-1

By R. A. Campbell, Aluminum Company of Canada Limited, Montreal, Canada; J. G. Sutherland, J. F. Whiting, and R. A. Kemp, Aluminum Laboratories Limited, Kingston, Canada. 1958 ASME-AIEE Joint Railroad Conference paper (multilithographed; to be published in *Trans. ASME;* available to Feb. 1, 1959).

The impact tests at collision speeds reported in this paper demonstrate that aluminum has high impact resistance. The tests also prove that the welded aluminum center sill met the published design requirements of the Association of American Railroads. Moreover, valuable data were obtained on body-to-sill connections and on the performance of draft gear and rear draft lugs. The information gained from these tests already has been incorporated in the design of 30 welded aluminum hopper cars built for the Roberval and Saguenay Railway in 1957, as well as the 17 covered welded aluminum hopper cars now on order for Aljam, and the 5 all-aluminum refrigerator cars now on order for the Canadian National Railways.

Instruments and Regulators

Optimal Synthesis of Linear Sampling Control Systems Using Generalized Performance Indexes.....58—IRD-6

By R. E. Kalman and R. W. Koepcke, International Business Machines, Poughkeepsie, N. Y. 1958 ASME Instruments and Regulators Conference paper (in type; to be published in *Trans. ASME;* available to Feb. 1, 1959).

This paper is concerned with the design of linear control systems so as to minimize some quadratic performance index. The method of design is applicable to both sampling and continuous control systems. Using the concepts of "state" and "transition matrix," the design problem can be solved, via the technique of dynamic programming, by means of simple iterative computations. In this way, the classical Wiener method of design is extended in several different directions: (*a*) Using generalized performance indexes; (*b*) optimizing for classes of input signals rather than single inputs; (*c*) assuring stability of the optimally designed system.

Time Domain Synthesis of Sampled-Data Control Systems...58—IRD-8

By E. I. Jury, University of California, Berkeley, Calif.; and F. W. Semelka, Ramo-Wooldridge Corporation, Los Angeles, Calif. 1958 ASME Instruments and Regulators Conference paper (multilithographed; to be published in *Trans. ASME;* available to Feb. 1, 1959).

The application of the modified z-transform to synthesis of sampled-data control systems is dealt with in this paper. The applicability of the modified z-transform as an analysis tool has been demonstrated in recent publications. Currently, this transform method is being developed to reduce the process of synthesis of both sampled-data and continuous systems to systematic, straightforward numerical processes.

In several recent papers, the z-transform has been applied to synthesis of sampled-data systems in both time and frequency-domain methods. From these papers and their discussions, the need for the refinement in synthesis to include the continuous response characteristics is apparent. The synthesis procedure presented is a time-domain technique which permits the designer to achieve control of the continuous behavior of the system. The desired characteristics are specified in terms of standard synthesis criteria, and from such specifications the required compensation transfer functions are determined.

Subharmonic Oscillations of Nonlinear Feedback Control Systems..58—IRD-7

By Katsuhiko Ogata, University of Minnesota, Minneapolis, Minn. 1958 ASME Instruments and Regulators Conference paper (in type; to be published in *Trans. ASME;* available to Feb. 1, 1959).

An analysis on subharmonic oscillations as responses of nonlinear feedback control systems is presented in this paper. The nonlinearities treated in this paper are those whose input-output characteristic curves show saturating or limiting characteristics and are skew symmetric with respect to their origins. The analysis shows that the outputs of such nonlinear systems will oscillate either with the input frequencies or with odd order subharmonics of the input frequencies. This paper also presents a design aid for eliminating the possibility of subharmonic oscillations. Electronic analog computer techniques were employed to obtain the experimental results presented here.

Continuous Measurement of Characteristics of Systems With Random Inputs: A Step Toward Self-Optimizing Control.....58—IRD-5

By T. P. Goodman, Assoc. Mem. ASME, and R. H. Hillsley, Massashusetts Institute of Technology, Cambridge, Mass. 1958 ASME Instruments and Regulators Conference paper (in type; to be published in *Trans. ASME;* available to Feb. 1, 1959).

To achieve self-optimizing control, a signal which reflects changes in system dynamics must be available to actuate controller adjustments. In this paper a new technique is presented whereby changes in system parameters are detected from changes in the moments of the system impulse response. At the same time, changes in input statistical properties are detected by changes in the moments of the input autocorrelation function.

Recent investigations by Paynter and others have shown the importance of impulse-response moments as a means for characterizing the dynamics of a system.

By the technique described in this paper, these moments are determined continuously and directly from the random variations in the system input and output, without passing through the intermediate steps of obtaining the input-output correlation functions and the system's impulse or frequency response. The precision of measurement of the moments can be estimated statistically, so that the design specifications for the equipment required for any desired precision of measurement can be established. The new technique has been applied experimentally to a simple linear system with promising results.

Dynamic Analysis of a Boiler.....58—IRD-4

By K. L. Chien, E. I. Ergin, and C. Ling, Beckman Systems, Anaheim, Calif.; and Allyn Lee, U. S. Navy, Bureau of Ships, Philadelphia, Pa. 1958 ASME Instruments and Regulators Conference paper (in type; to be published in *Trans. ASME;* available to Feb. 1, 1959).

Dynamic analysis of a boiler is accomplished by certain approximations which reduce the nonlinear partial differential equations to linear ordinary time-differential forms, and make it possible to obtain the time-dependent functions of large numbers of boiler variables.

Linear equations thus obtained are solved by means of an electronic differential analyzer and open-loop response of drum pressure and water level for various input variables (feedwater rate, fuel-flow rate, and steam-flow rate) are shown as examples. A linearly controlled response of the same boiler is also given as an example of the flexibility of the method and the analog solution.

It is shown that the potentiality of the method is not limited to this initial study, but can be extended for greater accuracy with the availability of machine computation. Analog simulation of the boiler also makes it possible to investigate the effects of the boiler physical dimensions, heat, or mass-transport constants, and to verify some of the basic assumptions on the dynamic behavior of the over-all system.

Gyro - Integrating Mass Flowmeter.....58—IRD-3

By L. T. Akeley, L. A. Batchelder, Mem. ASME, and D. S. Cleveland, General Electric Company, West Lynn, Mass. 1958 ASME Instruments and Regulators Conference paper (in type; to be published in *Trans. ASME;* available to Feb. 1, 1959).

The gyro-integrating mass flowmeter described in this paper, has been designed primarily for metering high-pressure natural gas. It is designed to meet explosion-proof requirements for indoor and outdoor applications at operating pressures up to 2000 psi. The meter is designed for an integrating accuracy of 1 per cent over 30 to 100 per cent of its flow rating. It reads mass of gas flow directly on a 6-dial cyclometer register, viewed through a window in the upper casing. The high-speed dial reads 10 lb per digit, a flow capacity allowing monthly reading at 10,000-lb-per-hr flow rate, if desired. Electrical contacts, operating once per 10 lb of flow, provide means for remote integration and/or indication. Electric power at 120-volt, 60-cycle (approximately) and of about 20 watts is required to operate the meter.

An Optimalizing Computer Controller for the Electric Utility Industry..58—IRD-2

By L. C. Kirchmayer, Mem. ASME, General Electric Company, Schenectady, N. Y. 1958 Instruments and Regulators Conference paper (multilithographed; available to Feb. 1, 1959).

An automatic dispatching system has been developed by General Electric. The system simultaneously and automatically maintains frequency, net interchange, and economic allocation of generation according to incremental theories for a given operating area.

Net interchange is defined to be the sum of the flows over the tie line between the given operating area and its neighbors.

This automatic dispatching system includes analog computing loops which insure that the turbine-generators within the utility system are loaded according to incremental cost theories, thus resulting in minimum fuel expenditures. Also, the application of a differential analyzer as a tool in the design of this automatic dispatching system is described.

The differential analyzer application includes: (*a*) Complete differential-analyzer simulation of power system and dispatching system to determine optimum design of regulating and economic loops. (*b*) Differential-analyzer simulation of power system tied together with prototype control components to study and evaluate prototype equipment.

An Adaptive Humidity Control System.....58—IRD-1

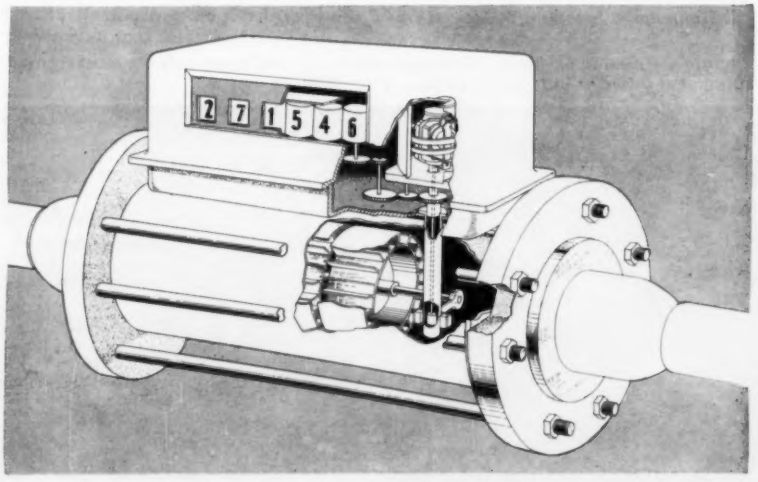
By G. K. Tucker, Minneapolis-Honeywell Regulator Company, Philadelphia, Pa. 1958 ASME Instruments and Regulators Conference paper (multilithographed; available to Feb. 1, 1959).

Application of an adaptive humidity control system is described. Adaptive control refers to the ability of a system to change its own parameters in response to a measured change in operating conditions. Using instrumentation techniques which are well established in the field of process control, this humidity-control system adapts itself to changes according to a relationship with specific disturbances.

The process is described; some of the characteristics which make satisfactory control difficult are noted; and a control system is suggested for the application.

Instrumentation for the system is evaluated and some of the equipment limitations which influence its selection also are discussed.

Gyro-integrating mass flowmeter installed in a pipeline. Cutaway view showing transmission of torque from turbine to gyroscope and subsequent gearing to register. Also, flange and bolt arrangement for installation purposes is shown. (58—IRD-3)



Maintenance and Plant Engineering

Engineered Maintenance as a Tool of Management.....58—MPE-4

By H. W. Shockley, Maintenance Consultant, Wilmington, Del. 1958 ASME Maintenance and Plant Engineering Conference paper (multilithographed; available to Feb. 1, 1959).

The necessity of better maintenance control is the result of automation, electronics, highly specialized equipment, need for better control of product, and lower operating costs.

In order to meet current standards and have engineered maintenance at low cost with high performance, it is necessary to fulfill certain minimal requirements. These requirements cover six categories: Organization; work execution; preventive maintenance; corrective maintenance; costs, controls, and performance measurement; and improvement programs. Each of these categories is discussed in detail.

Development of a Basic Maintenance Control System...58—MPE-3

By S. G. Hallett, Jr., Assoc. Mem. ASME, Continental-Diamond Fibre Corporation, Newark, Del. 1958 ASME Maintenance and Plant Engineering Conference paper (multilithographed; available to Feb. 1, 1959).

Many industrial plants, having used modern methods of maintenance control for years, are now concerned with application of advanced techniques to specialized maintenance problems. In many other plants, however, the maintenance unction has been severely neglected.

Symptoms of such neglect may be recognized in disorderly shops, an apathetic attitude of mechanics and foremen, makeshift repair work, valve and trap leaks, unpainted machinery, and other indications of low maintenance standards.

Management becomes aware of frequent disruptions to production-control schedules caused by equipment breakdowns, excessive production costs, erratic performance of machinery, high accident rate, and such.

Finally, the customer feels the result of ineffective maintenance through late deliveries, inconsistent product quality, and, eventually, higher cost.

This paper proposes an approach to the problem of maintenance neglect. It suggests a minimum program for increased maintenance effectiveness.

The primary concern of the program is recognition of the problem. The development of a basic system of control follows and includes organization, inventory control of spare parts and stores, an equipment record system, work order systems, a scheduling system, and backlog control.

A Practical Approach to Vibration and Balancing Problems in Machine Maintenance.... 58—MPE-5

By R. T. Buscarello, Assoc. Mem. ASME, Stewart-Warner Corporation, Chicago, Ill. 1958 ASME Maintenance and Plant Engineering Conference paper (multilithographed; available to Feb. 1, 1959).

Dynamic balancing and vibration problems play an important role in the maintenance of machinery. This paper deals with the main factors responsible for vibration which are encountered in maintenance of machinery and equipment. A roll or pump impeller can be manufactured to very close tolerances and can be well designed so that it operates in the correct manner, but often in spite of all the care and precautions taken, the equipment of which it is a part does not perform satisfactorily due to excessive vibration. These vibrations often limit the cutting speeds or other operating speeds that are desirable. Excessive wear of cutters, grinding wheels, and other perishable tools, require that harmful vibration be eliminated. Some effects of vibration are unsatisfactory bearing life, poor surface finish, difficulty in holding tolerances, displacement of windings in electric motors, as well as actual failure of machine parts due to progressive fracture. Excessive noise is a side effect which often reduces efficiency of the operators.

This paper explains the meaning of static, kinetic, and dynamic unbalance and how these different forms can be recognized or avoided in the maintenance work performed on industrial machinery. Critical speeds, resonant frequencies, their effects on machinery and means for avoidance or changing, as well as other vibration problems are discussed with the layman in mind. All examples are taken from actual case histories.

Optical Tooling and Its Uses in Industrial Plants.....58—MPE-2

By J. L. Hanold, Keuffel & Esser Company, Hoboken, N. J.; and H. R. Osmick, E. I. du Pont de Nemours & Company, Inc., Wilmington, Del. 1958 ASME Maintenance and Plant Engineering Conference paper (multilithographed; available to Feb. 1, 1959).

Immediately following World War II, the United States Air Force sponsored a development program by the airframe manufacturers for the use of optics in airframe tooling. As a result of the program, there is not a single aircraft manufacturer today who does not use optics.

In optical tooling the primary concern is with tolerances that are measured in thousandths of an inch and seconds of arc. With the trend today toward larger and faster machines, more accurate alignment is required.

Greater accuracy, however, is not the only advantage of optical tooling. Occasionally, optical tooling is purchased because there is no satisfactory alternative method available, and also because the customer is convinced that optical tooling will save him money in manhours.

A section of the paper defines the following terms: Optical micrometer, paired-line targets and scales, auto-reflection, alignment collimator, and autocollimation.

The principles of optical tooling are explained in reference to determining whether an object is straight, flat, plumb, or square.

In the shipbuilding industry, optical tooling is being used to align shaft bearings, establish witness lines of boring operations, and controlling the shipboard machinery of steam catapults.

The second part of this paper describes in detail some actual optical-tooling applications in industries other than aircraft and shipbuilding.

Cellophane casting machine. Optical methods are used to provide the most accurate alignment possible for such facilities. (58—MPE-2)

Metals Engineering

Welding Low-Alloy Steel Castings .....58—MET-4

By N. A. Chapin, C. H. Soldan, and L. W. Songer, General Electric Company, Schenectady, New York, N. Y. 1958 ASME-AWS Joint Metals Engineering Conference paper (multilithographed; available to Feb. 1, 1959).

The service requirements of modern steam-turbine generator equipment necessitate that casting weldment components have high strength and maximum reliability. The fabrication and repair welding of large alloy-steel castings for use in steam turbines operating at temperatures up to 1050 F and at pressures up to 3500 psi are described in this paper.

The technical aspects of processing operations for the manufacture of a large steam-turbine casting-weldment are discussed under four classifications: (*a*) Interrelation of casting and fabrication design; (*b*) welding metallurgical aspects; (*c*) welding process techniques; and (*d*) quality control and records.

Sound welds can be made in heavy-walled, low-alloy steel castings by the metal-arc welding processes if closely controlled procedures are followed. The process to be used must be selected to suit the size of the component and the position in which it is to be welded. Manual submerged-arc welding is especially suited to repair and planned welding, and also will complement the other processes. Heat-treatment, both pre and postweld, plays an important role in final quality and serviceability of welds. Consideration of sound foundry practices and provision for accessible welds which can easily be nondestructive inspected are design requirements. Higher quality components can be made by using better quality individual parts, which have been made from the best suited material, in the most economical manner and welded together. The importance of quality control in welding of high-pressure, high-temperature cast-weldments is paramount.

Properties Affecting Suitability of 9 Per Cent Nickel Steel for Low-Temperature Service....58—MET-3

By T. N. Armstrong, The International Nickel Company, Inc., New York, N. Y.; J. H. Gross, Lehigh University, Bethlehem, Pa.; and R. E. Brien, The International Nickel Company, Bayonne, N. J. 1958 ASME-AWS Joint Metals Engineering Conference paper (multilithographed; available to Feb. 1, 1959).

The mechanical properties of a low-carbon 9 per cent nickel steel intended for low-temperature service and the effect of some fabrication operations on these properties are described. Charpy values for both keyhole and V-notch specimens are reported for test temperatures down to −320 F and results are given for drop-weight tests on ½-in. and 1-in. plate at −320 F. Details of welding procedures using both the metal-arc process with covered electrodes and the inert-gas metal-arc process are described and test values for welds made by each process are given. Fatigue properties and comparison of plastic fatigue strength with that of several other pressure vessel steels are included. Data on effect of up to 10 per cent plastic strain on impact properties and effect of subsequent thermal stress-relieving are presented.

Design Values for Thermal Stress in Ductile Materials.....58—MET-1

By B. F. Langer, Mem. ASME, Westinghouse Electric Corporation, Pittsburgh, Pa. 1958 ASME-AWS Joint Metals Engineering Conference paper (multilithographed; available to Feb. 1, 1959).

A fundamental difference between thermal and mechanical stresses is that yielding produces relaxation of the thermal stress. Therefore it follows that the methods used for safety evaluation of load stresses should not be applied to the calculated values of thermal stress. In this paper methods are proposed for the application of strain-cycling data to practical design problems involving thermal stress. The subjects considered include multiaxial stress conditions, combined steady and alternating stress, and cumulative damage.

It is shown that when the calculated thermal stress exceeds the yield stress of a ductile material, some of the commonly used concepts, such as the Soderberg diagram, must be modified. The design methods proposed constitute safe approximations which are consistent with the experimental data available.

Casting-Weldments in a Petroleum Refinery.....58—MET-5

By J. Bland, C. B. Parrish, and R. C. Wheeler, Standard Oil Company (Indiana), Whiting, Ind. 1958 ASME-AWS Joint Metals Engineering Conference paper (multilithographed; available to Feb. 1, 1959).

Casting-weldments are being used to an increasing extent in process lines and equipment for oil-refinery applications. The several studies which have been made of castings used in these services have demonstrated the satisfactory weldability characteristics of these items. It should be emphasized, however, that careful control of metal analyses and foundry practices must be exercised in order to obtain sound, weldable castings. When these are available, there is no hesitation in using them within the design and stress limitations imposed by applicable codes.

The use of casting-weldments is dictated, of course, by the factors of economy and complexity of the item. In general, castings may be expected to be less expensive than forged or wrought items of similar applications. In some cases, the complexity of castings is such that it is more feasible to make one or more smaller less complex castings or wrought parts and assemble these, by welding, into the completed equipment.

The maintenance of casting-weldments imposes no greater problem in general, than that inherent in the vessels, lines, or other equipment encountered in a petroleum refinery. This is true, however, only if the material of the casting is readily weldable. Sufficient information as to the chemistry and prior history (as of heat-treatments) of the casting should be available to provide a basis for the selection of the correct welding procedure details.

Design of a Thin-Walled Cylindrical Pressure Vessel Based Upon the Plastic Range and Considering Anisotropy.....58—MET-2

By J. Marin, Mem. ASME, and M. G. Sharma, The Pennsylvania State University, University Park, Pa. 1958 ASME-AWS Joint Metals Engineering Conference paper (multilithographed; available to Feb. 1, 1959).

Various methods and theories of failure have been used to determine the wall thickness of pressure vessels. These theories and methods are based upon simple tensile yield strength or ultimate strength and have been reviewed thoroughly by Burrows. In using simple tensile yield or ultimate strength as a basis for failure, no consideration is given to the plastic deformation properties of the material. That is, these theories assume that two materials with the same tensile yield or ultimate strengths but with different ductilities are equally satisfactory to the designer. In other words, the determination of the failure load for a pressure vessel should consider the plastic stress-strain behavior of the material to failure.

This paper develops a theory for finding the wall thickness of a thin-walled cylindrical pressure vessel based upon the plastic range and so-called "instability" or maximum pressure that can be produced in the vessel. A paper by W. E. Cooper covers a similar theory for isotropic materials. This paper extends the theory to nonisotropic materials.

In addition, comparisons are made between available test results and theory.

Comparisons with current design code requirements are also included. For certain materials, temperatures and states of combined stress, brittle-type material behavior occurs with relatively small plastic deformations being produced prior to fracture. Failure under these circumstances is the brittle cohesive type of failure. Materials and conditions with this latter type of behavior are not included in this present discussion.

Co-operative Investigation of a New Welding Electrode for Stainless Steel.....58—MET-6

By R. D. Wylie, The Babcock & Wilcox Company, Barberton, Ohio. 1958 ASME-AWS Joint Metals Engineering Conference paper (multilithographed; available to Feb. 1, 1959).

A new stainless-steel arc-welding electrode, Croloy 16-8-2, is discussed. Data presented are the result of tests in a number of different laboratories and represents a summary of the work of many groups in evaluating a new welding procedure for use in high-temperature steam piping. The author feels that much has been accomplished by these welding procedures in minimizing fabrication problems, but that more work should be done to produce wrought materials with better weldability characteristics.

A number of utilities have welds of this type in service both in the piping systems and turbines, and in superheaters at temperatures from 1050–1200 F. Experience to date has been generally satisfactory, although some cracking has developed. This is to be expected, since in general this material was used to weld joints on which extreme difficulties had arisen using Type 347 electrodes.

Experience in welding of this material indicates that not all cracking can be eliminated by electrode specification. A change in the wrought material for piping probably will be required to eliminate all of the difficulties with pipe welds in fabrication and service. However, welds made with 16-8-2 generally indicate superior welding properties.

Welding Qualification and Component Performance.....58—MET-8

By W. L. Fleischmann, Mem. ASME, Knolls Atomic Power Laboratory, General Electric Company, Schenectady, N. Y. 1958 ASME-AWS Joint Metals Engineering Conference paper (multilithographed; available to Feb. 1, 1959).

From a designer's point of view the characteristic feature of welded design is the continuity of the welded structure. Failure analysis of welds in such a monolithic structure is difficult because the part and the weldment are mechanically speaking one part. Thus it has to be ascertained whether the cause of failure is associated with the process of welding, including the choice of weld metal, whether the weld was incorrectly designed or whether failure was due to the over-all design, residual stresses, or operation of the equipment.

Specific weld metallurgical problems are discussed as they pertain to the weld heat-affected zone, the weld deposit, joint design, weld quality, and weld-quality control.

This paper attempts to show that component performance and weldability tests are interrelated and that, in the context of component performance, weldability tests assume the role of simulated service tests. Joint welding-procedure qualifications have been found to be made under rather closely controlled conditions and many tribulations associated with weld fabrications are due to insufficient attention to details.

The conclusion has been reached that weld qualification should include "workmanship" standards. These workmanship standards can be an effective tool for quality control on the floor of the fabricating shop so that the nondestructive tests performed on the completed welds can be passed with great assurance.

Pressure Equipment for Low-Temperature Service.....58—MET-9

By C. R. Soderberg, Jr., Assoc. Mem. ASME, The M. W. Kellogg Company, New York, N. Y. 1958 Joint ASME-AWS Metals Engineering Conference paper (multilithographed; available to Feb. 1, 1959).

A design basis for the use of ferritic materials in atmospheric and low-temperature service is formulated. A brief summary of the present state of knowledge in that area is outlined. Much information is available on the subject of brittle fracture and while there is considerable detailed knowledge about specific materials, there is not a consistent test which has been used to evaluate all materials. The four most common test categories—stress level in path of advancing crack, fracture appearance, ductibility, and impact energy—are outlined. Materials and fabrication are also included in this review.

The inadequacies of present knowledge and correlation with service are noted. Limitations and economics of presently available ferrous materials and vessel fabrication are considered. An approach for the avoidance of brittle failure is suggested.

Current information is such that any design basis must be a compromise between laboratory and theoretical knowledge of brittle fracture on one hand and the reasonably adequate service record on the other. The implications of this compromise are discussed.

Welding Metallurgy of Cr-Mo-V for High-Temperature Steam-Turbine Components.....58—MET-7

By R. J. Christoffel, R. M. Curran, Mem. ASME, F. H. Domina, and C. H. Soldan, General Electric Company, Schenectady, N. Y. 1958 ASME-AWS Joint Metals Engineering Conference paper (multilithographed available to Feb. 1, 1959).

The procedures, including preheat and postweld heat-treatments which were developed for welding Cr-Mo-V base metal with a $^1/_2$ per cent Cr—1 per cent Mo electrode using both the manual metal-arc and submerged-arc processes are presented. The rupture strength of the $^1/_2$ per cent Cr—1 per cent Mo weld metal, as well as that of other low-alloy-steel weld metals, was evaluated and found to be less than that of the base metal. The effect of composition and heat-treatment on the rupture strength of low-alloy-steel weld metals was evaluated. A Cr-Mo-V electrode was developed and qualified for welding the Cr-Mo-V base metal which, in the normalized and tempered condition, had a rupture strength comparable to that of the base metal.

Welding Cast Components for Nuclear Power Application.....58—MET-10

By W. H. Rice, Electric Steel Foundry Company, Portland, Ore. 1958 Joint ASME-AWS Metals Engineering Conference paper (multilithographed; available to Feb. 1, 1959).

Specifications for quality control of materials and workmanship for nuclear applications are far more rigid than foundries have encountered in the past and are becoming increasingly so as additional information is obtained.

Base materials involved include austenitic and martensitic stainless steels as well as carbon steel. Additional alloys are being investigated thoroughly for potential future use. An extensive testing program is necessary to determine if the base metal, weld, and fusion zone fully meet the required mechanical and metallurgical properties both as welded and after heat-treatment.

Welding-procedure specifications normally require use of either metallic-coated electrodes or the metallic inert-gas process. Operators must prove their proficiency by passing rigid qualification tests for each type of alloy used. Weldability-evaluation tests also are performed on individual castings in the vicinity of the weld that is to tie the cast-

Two pump halves are fitted and tack welded with a consumable insert fitted into the joint for an inert-gas backed heliarc root pass (58—MET-10)

ing into the system. Close control and inspection must be exercised over each stage of production. This includes joint-groove preparation, sequence of welding, maintenance of preheat, and interpass temperatures, cleaning and inspection of each weld bead, grinding craters, and between passes, dye-penetrant examination during welding, postweld heat-treatment, machining, and radiographic inspection. When castings and cast weldments are ready for shipment they must be as perfect as can be determined by modern inspection devices.

Gas Turbine Power

New Gas Turbines for the Steel Industry.....58—GTP-3

By Z. S. Stys, Mem. ASME, Brown Boveri Corporation, New York, N. Y. 1958 ASME Gas Turbine Power Conference paper (multilithographed; available to Jan. 1, 1959).

Gas turbines have been in successful operation in many fields for quite some time. The particular field of interest in this paper is the application of the gas turbine to the steel industry. Although there are comparatively few units installed and in service in this industry, their reliability and particular suitability for the service for which they are intended created a new interest among the engineering staffs of steel mills, and economic considerations induced the management of these mills to purchase new units of approved design for generating power or driving blast-furnace blowers.

The historic development and layout, as well as the various governing aspects of these units burning blast-furnace gas and built for use in the steel industry, are described.

Production Engineering

Automatology Applied to Data Processing.....58—PROD-1

By A. F. Maynard, General Electric Company, Utica, N. Y. 1958 ASME Production Engineering Conference paper (multilithographed; available to Feb. 1, 1959).

In spite of the universal usage now acquired by the word "automation," it would be surprising if it has a common meaning for everyone. In the author's department of the General Electric Company, it means "the accomplishment of any work task by a power-driven, integrated machine, wholly without the direct application of human energy, skill, or intelligence." Further, automation is viewed as a universally applicable systems philosophy comprising industrial research, economic analysis, product design, machine design, machine construction, and machine utilization. The term "automatology," which is defined as "the process of establishing, developing, and applying the principles of automation," was coined to stress the fact that an over-all systems approach to automation is much more than just the utilization of machines, it is a technology in itself.

This paper outlines a basic approach to the problem of automation and mechanization; and describes the development of a specific automated data-processing system.

Cut Inventories—Cut Stock Outs... .....58—PROD-4

By N. V. Reinfeld, National Institute of Management, Inc., Cleveland, Ohio. 1958 ASME Production Engineering Conference paper (multilithographed; available to Feb. 1, 1959).

Inventories can be separated into two distinct categories: Working inventory and cushion or protective stocks. Stock-record cards reflect this distinction, to a certain extent, when they contain "max" and "min" figures, and, in some cases, reorder point. In this paper these terms are used to mean the following: Max is the order quantity; min is the safety stock or cushion; reorder point is the level at which stocks are reordered.

The inventory of a firm is shown graphically and related to the stock-record card. The problem of determining reorder points, cushion, and economic order quantities is discussed.

Examples of several cases are cited to illustrate obscure points. The problem of reorder points and cushion are then discussed in detail, with charts given that help simplify the calculation and increase the usability of the methods employed.

Examples of Reorder Control Systems.....58—PROD-2

By R. G. Brown, Mem. ASME, Arthur D. Little, Inc., Cambridge, Mass. 1958 ASME Production Engineering Conference paper (multilithographed; available to Feb. 1, 1959).

A fundamental rule for deciding when to place an order to replenish stock and rules for deciding how much to order are illustrated in this paper.

Examples of stock records, which show date, sales, receipts, stock on hand, new replenishment order, stock on order, available stock, stock adjustment order, and order point, for four products are used to illustrate the effects on inventories of variations in lead times, and of order-quantity rules.

These records also demonstrate a simple direct way of periodically adjusting the order point to reflect any changes in demand apparent in sales to date.

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The Computer in Job-Shop Production Control.....58—PROD-6

By W. B. Pirnie, Jr., Jones & Lamson Machine Company, Springfield, Vt. 1958 ASME Production Engineering paper (multilithographed; available to Feb. 1, 1959).

The use of a computer can be helpful in controlling the conflicting problems of providing optimum customer service, maintaining optimum inventories, providing an even flow of work for the shop, and producing the work economically. This paper describes the application of electronic data-processing equipment to the operation of production-control systems in a large job shop.

The basic principles of controlling work in process are few and simple: schedule all work, dispatch according to schedule, load to known capacities, know where the work is, keep track of its progress, and take action accordingly.

The speed and accuracy of the computer processing masses of detailed information take a lot of the guesswork out of planning shop operations, permitting shop managers to make sound decisions based on known and evaluated facts.

ASME TRANSACTIONS

THE June, 1958, issue of the *Transactions of the ASME*, which is the *Journal of Applied Mechanics* (available at $1 per copy to ASME members; $1.50 to nonmembers), contains the following papers:

Papers for Third U. S. National Congress of Applied Mechanics.

Stress Distributions Around Hydrostatically Loaded Holes, by A. J. Durelli and A. S. Kobayashi. (57—A-4)

Cutting of Metal Plates With High Explosive Charges, by W. E. Drummond. (57—A-89)

New Method to "Lock-in" Elastic Effects, by J. W. Dally, A. J. Durelli, and W. F. Riley. (57—A-71)

Torques on a Satellite Vehicle From Internal Moving Parts, by R. E. Roberson. (57—A-39)

Initial and Subsequent Yield Surfaces in Plasticity, by P. M. Naghdi, F. Essenburg, and W. Koff. (57—A-37)

Effect of Finite Rotations on Gyroscopic Sensing Devices, by L. E. Goodman and A. R. Robinson. (57—A-30)

Torsion in Presence of Steady Creep, by S. A. Patel, B. Venkatraman, and P. G. Hodge, Jr. (57—A-27)

Calculation of Optimum Concentrated Damping for Continuous System, by R. Plunkett. (57—A-93)

Inertia Forces in Slider-Crank Mechanisms, by Ernst Mewes. (57—A-41)

Redundant Trusses of Elastic-Strain-Hardening Material, by Hans Ziegler. (57—A-28)

A Compressible Elastic, Perfectly Plastic Wedge, by D. R. Bland and P. M. Naghdi. (57—A-38)

Stress Distribution in Rotating Disks and Cylinders, by A. M. Wahl. (57—A-91)

Large-Deflection Analysis for Pressure and Heating, by M. L. Williams. (57—A-14)

General Instability of Ring-Stiffened Shells, by G. D. Galletly, R. C. Slankard, and E. Wenk, Jr. (57—A-73)

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Criterion for Flow of a Bingham Plastic, by P. R. Paslay and A. Slibar

Static and Dynamic Deformation in Armco Iron, by H. P. Tardif and W. Erickson

Torques on a Satellite Vehicle (Supplement), by R. E. Roberson

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Stresses in a Rotating Dumbbell-Shaped Disk, by B. B. Chatterjee

Displacement Discontinuity Between Two Dissimilar Solids, by J. T. Frasier

Second Acceleration in Four-Bar Mechanisms, by W. J. Carter

Large Deflection of Cantilever Beams, by Kiichi Satō

Heat Transfer in Swirling Laminar Pipe Flow, by R. Siegel and M. Perlmutter

Levy-Type Solution for Rectangular Plate, by H. D. Conway

Discussion

Of previously published papers by G. W. Sutton; G. R. Irwin; Ching-Yuan Neou; P. G. Hodge, Jr.; S. Mahalingam; A. A. Betser and M. M. Frocht; J. J. Bailey; S. H. Crandall; G. Gerard and A. C. Gilbert; A. Slibar and P. R. Paslay; B. A. Boley and A. D. Barber; J. Duffy and R. D. Mindlin; D. C. Gazis and R. D. Mindlin; W. H. Hoppmann, II, and L. S. Magness; L. W. Lassiter; C. P. Atkinson; G. Horvay and K. L. Hanson; R. M. Cooper.

Book Reviews

Includes Letters from Readers on Miscellaneous Subjects

COMMENTS ON PAPERS

Let's Make It a Profession

To the Editor:

THREE articles in MECHANICAL ENGINEERING—"A Survey of the Engineering Profession," by William F. Ryan; "Are Engineers Professional?" by V. Paschkis, published in the November, 1957, issue, pp. 1036–1038 and 1076, respectively; and "Professional Development and Engineering Registration," by E. T. Donovan, in the Junior Forum, March, 1958, pp. 148–149—bring to mind that we engineers have come a long way over the past half century, but the path before us is a far cry from the modern turnpike. There is much to be desired.

Perhaps one of the most outstanding contributions inadvertently made by society to the field of engineering has been the adoption, by most states, of the Professional Engineering Act.

> "Be it enacted by the People of the State of Illinois, represented in the General Assembly:
>
> Section 1. In order to safeguard life, health, and property, any person practicing or offering to practice professional engineering is required to submit evidence. . ."

This excerpt from the Engineering Act is self-explanatory. However, the ramifications of this Act are, perhaps, obscure to most of my readers.

I am speaking, of course, of the much deserved and hard-fought-for recognition by society of the engineer as a professional man. Despite our efforts as individuals, and the efforts of our respective engineering societies, the public today has not completely overcome the inertia imposed by 50 years of ignorance of the engineer and his work. The enactment of the Professional Engineering Law has done much to overcome this inertia. Many engineers today are working hard to maintain and expand this small beachhead on public opinion. Unfortunately, many of our colleagues are not carrying their fair share of the burden. Professionalism can only be achieved by every practicing engineer becoming an active participant under the registration laws of his respective state.

To the skeptic: I do not imply that an engineer's license is the sesame of wealth, health, or public acclaim. I do maintain, however, that registration is a prerequisite to this recognition as professional men, which we all desire.

Every job title today associated with a profession is based on an earned degree followed by a period of supervised practice, a written examination with a display of talent, and crowned with a personal interview by one's peers. The Professional Engineering Act of the State of Illinois is based on this concept of preparedness. Those of you who have prepared to the point of examination, yet do not avail yourselves of the opportunity, are not carrying your share of the burden.

Professionalism carries the demand for higher salaries, pride of accomplishment, and, last but far from least, the acceptance of you as a learned contributor to the well being of your fellow man.

J. E. Baker.[1]

Engineers and World Conditions

To the Editor:

DURING the last five or six months, while our people and our government have become greatly excited as to a wide range of affairs—some of them threatening our existence—I have been at some pains, through careful scrutiny of the press and correspondence with our larger engineering organizations, to keep track of what contribution engineers have made to these fateful discussions. NSPE gave out a statement—apparently from its board—in essence deprecating enlarging the number of engineers in advance of a careful study as to the need. Mr. Hoover in the course of his address opening the $12-million drive for the new Engineering Societies Center contributed a few pithy paragraphs on the international situation. This is about all from engineers. And yet in the same period we have heard from scores of writers, scientists, and educators, not only criticizing what has been and is, but offering all manner of suggestion as to how progress can be made.

I am in receipt of a news release dated Jan. 10, 1958, apropos of the installation of Enoch R. Needles as president of EJC, of which organization ASME is a member. Even at this late date, all of four months after the agitation began, the head of an organization said to represent 250,000 engineers, 50 per cent of the nation's total, offered no suggestion as to what our engineering professionals ought to be doing in a situation admittedly crucial. Mr. Needles is quoted as saying with a minimum of reserve that "the technical force of the United States is capable of meeting any challenge to world supremacy, providing it is given the responsibility and administration it needs."

Why should we engineers wait to be given responsibility? President Needles has it as an individual engineer, as I have it as an individual engineer. Why is not the responsibility of 250,000 engineers overwhelming? Why do we have to be told like "hired hands" what to do? Without any official position, I have found by myself and in association with others, a half dozen ways in which I believe a contribution is being made. Cannot the head of what seems like a tremendous organization give it the leadership without waiting for [Dr. James R., Jr.] Killian to tell us what to do, as one high engineering-society official recently put it?

In making pronouncements on behalf of the engineering profession, our spokesmen seem to assume that the public knows all about us and is ready to concede that we are "hot stuff." I am not so sure about that. Lack of individual

[1] Application engineer, general purpose control department, General Electric Company, Bloomington, Ill. Mem. ASME.

and organized activity on the part of engineers in this time of stress speaks loudly. The convening of a Parliament of Science under the impressive auspices of AAAS, on March 15, 16, and 17, to prepare recommendations concerning some of the problems of support of science and improvement of education which are being widely discussed throughout the nation, bespeaks deep concern on the part of scientists.

Morris Llewellyn Cooke.[2]

Maintenance Problems

Comment by C. C. Carmine[3]

It would seem to me that none of the process industries should be more familiar today with the necessity for improving component reliability than that of oil refining.

More and more large combination units are being installed in petroleum refineries with the objective of obtaining optimum balance among throughput, product requirements, automatic process control, and manpower.

These units are aggregations of components such as fractionating towers, special burner and reaction vessels, pumps, turbines, motors, compressors, blowers, heat exchangers, and the like. Failures of the larger pieces of equipment are of such magnitude that their causes are usually determined by detailed inspection after their occurrence, followed by written reports and recommendations. Most oil refineries are staffed with an independent inspection department which carries out this function.

As for the smaller components, overall reliability is sought by providing for spare equipment. This pertains especially to such components as pumps, turbines, motors, blowers, and compressors. Heat exchangers are often valved in such a manner that individual or banks of exchangers may be taken out of service for cleaning, testing, or replacement of elements without shutting down the whole unit.

Now take this matter of provision for heat exchangers. Even though maximum reliability of the unit is desired, it is seldom that sufficient funds are allocated in the initial installation to provide for an excess of heat-exchange surface. In other words, when portions of the heat-exchange installation become fouled or in need of repairs, taking them out of service results in loss of production or loss of heat recovery.

As to the rotating machinery—pumps, turbines, motors, compressors, and blowers—provision may be made for spares at the original designed capacity. Sometimes with limited capital funds available even this is not done. But suppose it is. Tell me of an oil refining unit which, in a short time after its acceptance run, is not exceeding its original designed capacity with all rotating equipment, including spares, in operation.

This is where the maintenance function gets into the picture without ceremony or apologies. The components have to be made to operate, failure has to be prevented.

The problem then is to find out when failures occur and why. It becomes important to obtain data and records currently and economically. It follows that the recorded information should be analyzed to determine accurately what happened, how often, and why. Only then, it seems to me, can an objective appraisal be made and corrective measures taken.

The author of this paper[4] suggests that: "There is no limit to the amount of detailed data that can be obtained but there is an economical limit to the amount of manual recapitulation for analysis that can be considered." He proposes that record taking and recapitulation of machinery histories be done automatically with equipment "recently developed which records the data on punched-paper teletype tape."

In my opinion, this is a desirable approach to the problem of finding out why maintenance work is being performed.

It is doubtful whether it would be economical to install automatic recording devices in all operating units of an oil refinery for the purpose of analysis. Where, however, a major unit of critical importance to refinery operations is suffering excess down-time due to failures of machinery components and where it is desired to subject the failures to critical, historical analysis and take suitable corrective action, then the use of the equipment and methods described by the author impresses me as being practical and timely.

Comment by David Briansky[5]

I READ with considerable interest J. D. Quinn's article[4] on quality control.

I am the composer of a mathematical function by means of which can be represented analytically (mathematically) the curves appearing with the article (on page 933). The function I developed is

$$y = \Sigma A(x)\epsilon^{-k^2(x)\cdot\cot^{2m}(x)}$$

where ϵ is the Naperian base, which is very flexible and requires only a few terms thereof to construct the curves of the article appearing on p. 933; where y is the ordinate of the curve and x is the abscissa thereof, and the factors A, k, and m are suitable coefficients.

For example, the right-hand curve appearing on p. 933 can be represented closely by the series

$$Y = \Sigma A\cdot\epsilon^{-\cot^2 1.571\,(1\,-\,\epsilon^{-k^2x^2})}$$

a function that is far less formidable than it appears to be.

Author's Closure

Mr. Carmine mentioned the approach of a large refinery to assure continuity of production primarily through installed spare equipment. When this approach can be considered and justified, it certainly can provide a satisfactory answer. There are many cases, however, where this approach cannot be justified.

This situation requires that we have sufficient data concerning frequency and effect of component failures as justification for improvements, and later to know the value of the improvements. Any equipment utilized for this purpose only provides information for engineering analysis and development of solutions.

The extent to which equipment is utilized, whether for examination of a unit in the system or the entire system, is dependent of course on the need or justification. We will, I am quite certain, find use of equipment for performance analysis commonplace within the next few years.

Mr. Briansky's comments concerned the mechanical-failure curves. While mathematical models could be of value, the development of the curves shown is a simple, clerical function and, as such, has many advantages. In this kind of study we have not found it necessary to have a formalized model. Our principal concern has been the analysis of the distribution pattern of the failures to determine the causes of failure associated with the pattern.

J. D. Quinn.[6]

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[2] Consulting engineer, Chestnut Hill, Philadelphia, Pa. Fellow ASME.

[3] Supervisor of maintenance and construction, Avon Refinery, Tidewater Oil Company, Associated, Calif.

[4] "Developments in the Analysis of Maintenance Problems," by J. D. Quinn, MECHANICAL ENGINEERING, vol. 79, October, 1957, pp. 931–933. Condensed from ASME Paper No. 57—SA-81.

[5] Consulting engineer, New York, N. Y.

[6] Group supervisor, Maintenance-Consultants, Engineering Department, E. I. du Pont de Nemours & Co., Inc., Wilmington, Del. Mem. ASME.

Dust and Fume Control

Comment by W. O. Vedder[7]

It is appreciated the article[8] endeavors to condense a broad, increasingly complicated subject, but in some instances information is included not in conformity with actual practice nor in agreement with a number of authorities in this field.

The industrially important fabric-type collector is omitted from Fig. 1, covering methods of collection and particle size.

It is difficult to visualize an industrial-dust or fume-collection application where properly designed, applied, operated, and maintained cloth-type filters would not perform at higher collecting efficiency than that specified, nor exceed the efficiency of conventional cyclone, centrifugal wet, wet wash, or wet tower collectors.

The maximum cloth area per cu ft of collector is provided by the screen frame or envelope design of cloth collector which was one of the major factors leading to this design.

The conventional intermittent or sectional continuous designs of cloth filters equipped with mechanical cloth cleaning means are seldom operated at filtration rates from 5 to 15 fpm. The more normal rate is in the range of 2 to 4 fpm.

Normally, the cost of cyclone collectors would be less than either wet wash or tubular bag collectors.

Water quantities specified for multiple stage and orifice-type wet collectors are considerably higher and for wet centrifugal cyclones lower than normally used in practice.

It should be emphasized that the surest method of encountering trouble in the application of any type of dust collector is to endeavor to interpret and interpolate performance results secured on one specific application into terms of general application practice. There are too many variable factors from one industrial problem to another (and frequently on the same problem) which influence and govern collector performance. For this reason it is highly advisable to individually survey and analyze conditions on each specific problem.

Author's Closure

The paper[8] was written for definite purposes outlined therein. As Mr. Vedder points out it is difficult to condense the material on this subject in a short article. However, the need for such a paper was emphasized many times and publication of the paper fully justified the need by the scores of requests for copies since presentation at San Francisco in July, 1957.

All engineers engaged in the field fully recognize the significance of cloth-type dust arresters and the writer tried to offer adequate generalizations, based on actual practice, to help. Actually Fig. 1 contained these arresters, in the original form of the chart, but the reference at the time of condensation of the paper, namely "Settling Chambers and Wool Filters" was thought adequate for the purpose discussed. However, we are definitely in agreement that the caption, "Cloth Type Filters" would have been more comprehensive.

It was not considered advisable in view of the stated objectives of the paper to make any specifications as to velocity under the empirical figure of 5 fm. It is fully recognized that common practice under the figure of 5 fm is used in calculating cloth area for a specification relating to a specific cloth-type filter application.

Conservatism is the better part of engineering judgment, when general statements are being made in connection with educational material, as to choice for the dust loading, efficiency, and so on, versus investment.

Figures on water rate for multiwash collectors are gallons of water recirculated, not stored in the system, and checked fairly closely with actual performance on three installations. As to the orifice type, the quantity is the gallons of water stored. The figure may be slightly high. It is conservative for a high efficiency orifice unit which has been available for the last 20 years. It is agreed that a reduction of 10 per cent over figures in the paper would be probable.

In regard to the wet centrifugal collector, evidently the point was overlooked that the article states "Water is drained to the sewer at rate of $\frac{1}{2}$ gpm per 1000 cfm." The number of gallons of water from fresh water supply will depend on many factors including the specific design. In some instances this has run around 2 gpm per 1000 cfm.

The author fully agrees that the surest way to run into trouble in dust and fume-collection applications is to take general information and apply it to a specific problem. This danger, however, should not discourage engineers, familiar with these problems, to try and develop some educational information for the members of our profession.

J. C. Somers.[9]

[7] Vice-president, Pangborn Corporation, Hagerstown, Pa. Mem. ASME.

[8] "Dust and Fume Control," by J. C. Somers, Mechanical Engineering, vol. 79, November, 1957, pp. 1022–1024. Condensed from ASME Paper No. 57—SA-86.

[9] President, Industrial Products Engineering Company, L. I. City, N. Y. Mem. ASME.

Materials in Motion

Comment by Spaulding Schultz[10]

In this paper[11] the author discusses three analytical methods associated with Operations Research, namely: Work sampling, waiting line or queuing theory, and linear programming. Each of these methods is described in necessarily brief form to a preset time schedule. A specific example is cited in each case showing how the method can be applied to a materials-handling problem.

The purpose of the paper is to urge materials-handling analysts to adopt these newer analytical methods, although it is made clear that wider use should also be made of the graphical methods which have been successful for years.

While we agree with the author that analytical methods should have wider use in materials-handling problems, we wonder if he isn't overlooking what seems to be the real crux of the matter. As we all know, the methods discussed in this paper are not new. Articles pertaining to them have been presented at Society meetings three and four years ago—and perhaps many years before that. The real problem, it seems, is not how can newer and more analytical methods be adapted to materials-handling, but rather how can we get established ones into greater use.

Even in large industries where much emphasis is placed on research and development, there is a surprising lack of progress in utilizing analytical methods.

Doesn't the problem involve management as well as engineer acceptance of the methods to spur the use of them by the materials-handling engineer?

Author's Closure

Mr. Schultz is quite correct in emphasizing the problem of acceptance of new methods by management and by specialists. However, as the problem is universal and not unique to materials handling, it is suggested that one of the best ways to obtain acceptance is to have more papers which describe the successful use of new techniques.

A. F. Gould.[12]

[10] Engineer, Plant Layout and Material-Handling Service, Manufacturing Engineering Service, General Electric Company, Schenectady, N. Y. Assoc. Mem. ASME.

[11] A. F. Gould. "Materials in Motion." Mechanical Engineering, December, 1957, vol. 79, pp. 1116–1118, condensed from ASME Paper No. 57—F-26.

[12] Head of the Department of Industrial Engineering, Lehigh University, Bethlehem, Pa. Mem. ASME.

Aircraft Engine Overhaul and Maintenance

Comment on J. T. Farrah[13]

I WISH to congratulate the author on the presentation of a fine paper.[14] This is a good opportunity to point out the great spirit of co-operation which exists between the major airlines. We are strong competitors in the business world, but the finest co-operation is experienced in the solution of technical problems. Lack of reliability on the part of any operator hurts the industry in general. It is a wonderful thing that the airline industry recognizes these facts and the end result is a credit to all concerned.

We, in the airline engine overhaul business, have only three main problems; namely, quality, quantity, and cost. Fig. 3 of the paper presents the trend of engine overhaul costs. Great improvement is noted. One point, which I believe should be stressed, is the fact that low costs cannot be developed without high quality. This statement may seem to present a conflict. I do not infer that a large number of high-cost parts should be replaced without good judgment in the blind hope that high quality will result. I do believe that good judgment in the use of parts where really needed, combined with high-quality workmanship will result in high quality at low cost.

An important variable not mentioned is the time between overhauls. In the early 1940's where the cost curves were much higher than at present, 750 hr between overhauls was considered good. Some engines are now certificated for 2000 hr between overhauls. It is this improvement in reliability, brought about by 15 years' development work and continued good judgment in overhaul, which has played a large part in reducing costs.

The author states: "In summation, we believe that for an overhaul facility, engine-parts inspection is the focal point not only of quality control but parts-cost control, process-cost control, and parts inventory-cost control. This broad responsibility can only be administered properly by a single organization, the engine overhaul administration itself."

I wholeheartedly concur that engine-parts inspection is perhaps the most important function in engine-cost control; however, it does not necessarily follow that this important function can only be administered by the production organization.

At American the inspection department is under a separate organization completely divorced from the production group. This provides a check-and-balance type of organization which we believe tends to provide a good balance between cost and quality which already we have agreed are interdependent.

The common point of management at American is the vice-president—maintenance and engineering. Under the vice-president are two separate departments; namely, quality control and overhaul. This results in the common point of supervision of the two departments being two echelons removed from the day-to-day operating problems. The vice-president is available for any conflict which cannot be settled at the working level. It has not been necessary to call on the vice-president of maintenance and engineering to settle any such working problems.

The quality-control group inspect all parts after cleaning and before assembly of an engine. The appropriate reworks are designated by quality-control people. These usually are well-defined procedures outlined in the Overhaul Manual. In order to keep a check on costs and the parts thrown out by inspection, the major cost items are reviewed by supervisors of production. These people have the final authority to actually scrap a part. They do not have authority to reuse a part without the full approval of the inspection department. Where a new rework or salvage process is developed, concurrence is obtained among engineering, inspection, and production. As would be expected, there are times when this system presents conflicts of opinion. However, this is a healthy condition since a difference of opinion indicates a marginal decision which should be well considered.

I do not contend that we at American have the optimum solution; however, I do wish to point out that it is possible to run an engine shop with the generally accepted practice of divorcing the inspection department from production.

Comment by J. C. Steele[15]

Pratt & Whitney Aircraft, a division of United Aircraft Corporation, has been closely associated with United Air Lines, also once a division of the same corporation. The two companies, working together over the years, have done much to promote dependable engine performance, which has directly resulted in reduced operating costs. This reduction of costs, as the author of this paper[14] points out, has been a major factor in the rapid expansion enjoyed by United Air Lines as well as by other airlines.

Increased utilization of engines has been important in the over-all operating-cost reduction. The Pratt & Whitney R-2800 engine operated by United Air Lines in their DC-6 aircraft over a recent six-month period has shown a utilization of 93 per cent. During the same period the material and labor cost at overhaul per operating engine hr was only slightly more than $5. Airline inspection personnel working with Pratt & Whitney representatives function as watchdogs for engine trouble, supplying the necessary data to facilitate corrective action. The corrective action, in many instances, necessitates a campaign change to the engines in order to incorporate product-improvement design change. Such changes are accomplished at the time of the next overhaul of the engine or, if safety of flight is involved, are made while the engine is installed on the aircraft. All of the operators of Pratt & Whitney engines are kept advised of these changes by telephone, telegraph, letters, service bulletins, and special reports as well as by personal contact. Airline inspection has allowed the gradual increase of engine time between overhaul from 200 hr to the present-day high of 2000 hr. In the early 1930's an aircraft engine was considered worn out at 2000-hr total time and was scrapped. Today, the total time on the aircraft engine is well over 20,000 hr and is increasing.

With every new engine introduced, a basic tool list for maintenance and overhaul is provided by Pratt & Whitney. These tools are developed at the factory on new engines and, in some instances, need modification to fit into particular shop procedure. Pratt & Whitney makes available manufacturing information for these tools so that many of them are fabricated by the operators and some are contracted to various tool manufacturers. However, many improvements and complete redesigns have resulted from the daily use of these tools in airline overhaul shops. Some of the more outstanding of these have been previously illustrated by the author.

Tools as well as methods and results of inspection are promoted by Pratt & Whitney in co-operation with United Air Lines and other airlines through daily, personal contact by factory representatives. These factory personnel work as liaison between the factory and the air-

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[13] Manager, Power Plant and Accessory Overhaul, American Airlines, Inc., Overhaul & Supply Depot, Tulsa, Okla.

[14] S. P. Youngblutt, "Tools, Ideas, and People Perform Aircraft Engine Overhaul and Maintenance," MECHANICAL ENGINEERING, vol. 79, December, 1957, pp. 1123–1125. Condensed from ASME Paper No. 57—SA-38.

[15] Pratt & Whitney Aircraft Division (Redwood, Calif.), representative.

line to insure continued engine improvement by co-ordinating the problems of both the airline and the factory. The airlines and the factory have complimented each other's growth. It is this mutual understanding that has helped a great deal to get the job done in the best possible way and has resulted in reduced operational costs. Once a problem is defined, service tests of new or improved parts or procedures are set up by Pratt & Whitney and instituted by the airline in a portion of a fleet of engines. These tests are the result of ideas from both the airline and Pratt & Whitney who, by the nature of their task, are conservative in any approach to change or modification to the engine. As you well understand, dependability cannot be jeopardized. While new ideas are welcomed by the aircraft engine manufacturer, any proposed change must, because of the safety factor involved, be well researched before it is put into effect.

As the combination of tools, ideas, and people has proved in the past to advance the aircraft industry, it will continue to do so in the future. Without man the machine could not exist, and it is through man's efforts as directed towards both tools and machines in the factory as well as in the airline that the industry as a whole will continue to prosper.

Design by Logic

Comment by E. C. Berkeley[16]

I THINK this is an interesting, important, and useful paper.[17] It shows how Boolian algebra can be usefully applied in the logical design of chemical processes. The author is to be congratulated on presenting a new application of Boolian algebra (with extensions to take care of the variable of time), in the field of chemical process industries.

I shall make a few brief comments on several points.

1 *Size of Charts.* Many of the interesting concepts explained in this paper are expressed not in the text of the paper but in the charts. The preprints present these charts in a form too small to be easily read. I recommend that, when the final printing of this paper is arranged, the charts be made considerably larger so that the concepts they contain can be studied and absorbed more easily.

2 *Sign for the Inclusive "OR."* In my opinion a better sign for the inclusive "OR" is the small gothic v (v), which is the initial letter of the Latin conjunction "vel," which means "and/or," and is contrasted with the other Latin conjunction "aut" meaning "or else." The sign plus (+) for "and/or" in Boolian algebra has in the past few years generally given way to the sign "v."

One of the reasons for this is that when we deal with elementary algebra and the numbers 0 and 1, we obtain a complete Boolian algebra when we use the interpretations:

$$p \vee q = p + q - pq$$

$$p \cdot q = pq$$

$$\bar{p} = p' = 1 - p$$

3 *The Variable Time.* It is perhaps worth pointing out that the words of ordinary language "when, while, during, before, happen, after, delay, change, event, state, enter, leave," and other similar words, in at least some of their ordinary meanings, are translatable into Boolian algebra extended by a time variable, which the author discusses. For more information on this topic, and other applications of Boolian algebra, I would suggest that readers look at "The Axiomatic Method in Biology," by J. H. Woodger, published in Cambridge, England, by The University Press, 1937, 174 pp.; "The Algebra of States and Events," by Edmund C. Berkeley, in *The Scientific Monthly*, April, 1954; "A Symbolic Analysis of Relay and Switching Circuits," by Claude E. Shannon in *Transactions of the American Institute of Electrical Engineers*, vol. 57, 1938, pp. 713–723; and "The Design of Switching Circuits," by Keister, Ritchie, and Washburn, published by D. Van Nostrand & Company, 1951.

Author's Closure

Mr. Berkeley's comments are greatly appreciated and all valid. The use of (+) to represent (v) was an error in judgment brought on by pressures from other sources. There is another reason for distinguishing between these two symbols besides the one mentioned by Mr. Berkeley.

In order to describe the dynamic behavior of real systems which are discontinuous and subject to the action of the interlock circuits, it is necessary to combine transfer function notation with logic notation. This gives rise to the concept of a logic variable which "gates" or controls the existence of an analog variable by the multiplication of the two numbers. In such cases it is essential to keep elementary algebra, which can be applied to analog variables, separate from Boolian algebra, which applies to logic variables.

Thus complete system performance can be shown pictorially (or algebraically) and this provides the guide for system simulation using an analog computer in conjunction with a logic computer.

J. P. Laird.[18]

Aircraft Gas-Turbine Development

Comment by A. Stone[19]

THIS paper[20] provides a graphic illustration of some of the problems experienced during the development of a gas-turbine engine.

I should like to ask a question concerning bearing axial-thrust loading. The calculation of rotor axial thrust for bearing design purposes necessarily tends to be approximate, especially when considering off-design conditions, and it is important to measure the actual loading. This is not a simple problem. There are several possible solutions, but each seems to have its own peculiarities. What are Mr. Saboe's views on this matter?

Author's Closure

The following comments are offered regarding Mr. Stone's question on the subject paper.[20]

As Mr. Stone points out, the calculation of rotor axial thrust for bearing design purposes does tend to be approximate. Two techniques have been used to measure the actual axial load imposed under normal operating conditions. These are:

(*a*) Pressure balance measurements using pressure pickups in the various pertinent locations within the engine.

(*b*) The use of strain gages on the retention member for the bearing counteracting this axial force.

We have used both methods with reasonable results, although the second is a favored one. In the case of the latter, it is recommended that the bearing OD have a sliding fit within its retainer in order to minimize hysteresis effects caused by friction.

Michael S. Saboe.[21]

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[16] Berkeley Enterprises, Inc., Newtonville, Mass.

[17] J. P. Laird, "Design by Logic—Automatic Chemical Batching," MECHANICAL ENGINEERING, January, 1958, vol. 80, pp. 38–41, ASME Paper No. 57—A-151.

[18] Engineering Service Division, E. I. du Pont de Nemours & Company, Inc. Wilmington, Del. Mem. ASME.

[19] Engineer-in-charge, Aero-Thermodynamics Group, Solar Aircraft Company, San Diego, Calif.

[20] M. S. Saboe, "Developing an Aircraft Gas Turbine," MECHANICAL ENGINEERING, January, 1958, vol. 80, pp. 55–58, ASME Paper No. 57—A-143.

[21] Chief test engineer, gas-turbine department, Lycoming Division, Avco Manufacturing Corporation, Stamford, Conn. Assoc. Mem. ASME.

Notes on Books Received in Engineering Societies Library

REVIEWS OF BOOKS

Hydraulics

History of Hydraulics

By Hunter Rouse and Simon Ince. Iowa Institute of Hydraulic Research, State University of Iowa, Iowa City, Iowa, 1957. Cloth, 5¾ × 9 in., illus., references, index, xii and 269 pp., $5.

Reviewed by W. J. Rheingans[1]

THIS is the story of hydraulics, from the efforts of primitive man to solve practical problems of water supply, transportation, flood control, and irrigation, to the latest developments in fluid mechanics in the 20th century. The authors have succeeded in taking a subject which has the potentialities of a dull, historical collection of facts, names, and dates, and have presented it in such an interesting manner that the reader will be loathe to lay the book aside, particularly during its early chapters. The reviewer found that it has the attraction of a thriller or mystery novel in this respect.

Hydraulics is, of course, a tremendously large subject, and the authors have shown how some of the very earliest engineering talent was applied to its phenomena and the solution of some of its problems, both practical and theoretical. It was interesting to note that some of the practices of ancient days are still existent today. Take, for example, the ancient Roman method of metering water. The consumer did not pay for the amount of water which he actually used, but paid a flat rate for the lease of a certain discharge, which in turn was based upon the size of the distributing pipe. Compare this with the many cities that still supply unmetered water at a flat rate although the refinement of valves and stopcocks has been added.

The history starts with the use of water boilers, pumps, flood control, and irrigation in ancient Egypt, Archimedes' concepts of buoyance and flotation, and the Roman water supply. It continues with the start of mechanics in the middle ages, Leonardo da Vinci's principles of experimental designs, the introduction of methods and instruments for measuring velocities and flows, such as the wier, pitot, and venturi, as well as the parallel advancement in the theoretical solution of hydraulic phenomena. It ends with a review of present-day fluid mechanics and an appraisal of the science as it now stands. The book is definitely not a textbook, but no other text presents to the student of hydraulics and fluid mechanics a better concept of the fundamental problems and formula.

One thing the authors failed to do was to show the effect of the development of hydraulics on political history. It is quite certain that stream control, irrigation and water supply, their development and improvement, must have been a deciding factor in the destinies of many of our ancient civilizations. The development of hydraulic power in recent centuries has also had a direct influence on the growth and standard of living of many countries, the prime example being the United States. However, it is true that a study of this sort is in itself of sufficient scope to warrant separate treatment.

It is surprising that a clearcut fundamental formula for a free falling body, namely, $V = \sqrt{2gh}$, which is the basis of hydraulic power, was not accepted in its final form until the 18th century. However, this is probably not so strange, considering that, as late as the year 1900, William Kent, author of "Kent's Mechanical Engineer's Pocket Book" severely criticized the pitot tube formula $V = \sqrt{2gh}$. Among other things, Kent stated that, "$V = \sqrt{2gh}$ is a perfectly correct theoretical formula when the velocity is produced by the head, but it is incorrect when the head is produced by the velocity. . . . The correct theoretical formula is $V = \sqrt{gh}$ in this case."[2]

The authors have succeeded in bringing alive, placing in their proper perspective, and giving meaning to such time honored and ancient names as Leonardo da Vinci, Galileo, Torricelli, Pascal, Newton, Bernoulli, Pitot, Euler, Chezy, Venturi, Coulomb, Froude, and Francis to name just a few. Previously these were just names to the reviewer, but after reading the book they have become endowed with distinct personalities.

In addition to presenting a well-written, interesting, and lively history of hydraulics, the authors have made it possible to use it as a reference book on both the chronological history of hydraulics and the personal data of the leaders in this field. The value of the careful and detailed documentation of the personal lives and scientific contributions of the leaders in hydraulics and related fields outweighs the resulting heavy going found in some parts of the book.

The high lights of the history of hydraulics are indicated by the chapter titles:

Practical Hydraulics in Early Antiquity
Greek Concepts of Fluid Behavior
Roman Water Supply Systems
Mechanics of the Middle Ages
Naissance of the Experimental Method
Post Renaissance Hydraulics
17th Century Mathematics and Mechanics
The Advent of Hydrodynamics
Experimental Hydraulics of the 18th Century
Early 19th Century Advancements in Hydraulics
Late 19th Century Advancements in Hydraulics
Classical and Applied Hydrodynamics of the 19th Century
Hydraulic Trends in the 20th Century
The Rise of Fluid Mechanics
An Appraisal of the Science at Mid-Century

Of particular value for quick reference is the chronological table of the leaders in hydraulics and related fields starting with Archimedes in the third century, B.C., and ending with Freeman in the 20th century. This table lists the names

[1] Manager, hydraulic department, Allis-Chalmers Manufacturing Company, Milwaukee, Wis. Mem. ASME.

[2] *Transactions of the ASME*, vol. 22, 1901, p. 284.

of these leaders, their birth and death, and their major contributions to the science. The index of the subjects and the various men associated with the science is also well detailed.

The authors are particularly well qualified to write a history on hydraulics. Hunter Rouse is professor of fluid mechanics, State University of Iowa and director of Iowa Institute of Hydraulic Research. He has had a broad and varied experience in many phases of hydraulics. He is the author of "Fluid Mechanics for Hydraulic Engineers," "Elementary Mechanics of Fluids," and "Basic Mechanics of Fluids," and has written numerous articles for technical journals. In 1952–1953 he gave the major part of his year as Fullbright Research Scholar at the University of Grenoble to the history project, taking advantage of the superb library facilities of the neighboring Laboratoire Dauphinois d'Hydraulique.

Simon Ince studied under Hunter Rouse at Iowa in 1950 and prepared a history of hydraulics in 1951 and 1952 in part as a staff project at the Iowa Institute of Hydraulic Research. Simon Ince has considerable linguistic ability which was of great value in obtaining information from French, German, and Italian publications of various kinds.

The authors have expressed the keynote and justification of their book by quoting Gottfried Wilhelm von Leibniz (1646–1716) on historical research.

> **"It is an extremely useful thing to have knowledge of the true origins of memorable discoveries, especially those that have been found, not by accident but by dint of meditation. It is not so much that thereby history may attribute to each man his own discoveries and others should be encouraged to earn like commendation, as that the art of making discoveries should be extended by considering noteworthy examples of it."**

The "History of Hydraulics" is a must in the library of every person dealing with or interested in hydraulics or fluid mechanics.

BOOKS RECEIVED IN LIBRARY

La Machine-Outil
Tome 5. Usinage des Dentures et Filets. Edited by A. R. Métral. 1957, Dunod, Paris, France. 614 p., 7½ × 11 in., bound. Fr. frcs. 8800. Part of a comprehensive set on machine-shop practice, this volume provides a detailed-treatment of the theory and practice of gear-cutting. It contains extensive descriptions of machines and methods for generating, cutting, and testing of gear teeth with particular attention to the control of tooth shape and surface quality. The volume also covers screw thread production including modern methods of rolling, chasing, grinding, etc.

Les Mécanismes Hydrauliques
By J. Faisandier. 1957, Dunod, Paris, France. 210 p., 6 × 9¾ in., bound. Fr. frcs. 2200. A practical treatment of hydraulic power transmission devices. Chapter 1 covers general principles and the characteristics of the liquids used. The subsequent three chapters deal with the actual mechanisms: pump or other generator; receiving devices—jacks, hydraulic motors, servos; intermediate and auxiliary equipment—accumulators, distributors, valves, piping, etc. Specific applications to airplane and machine-tool operations are demonstrated.

Nonlinear Circuit Analysis
Proceedings of the Symposium, New York, 1956. Published 1957 by the Polytechnic Institute of Brooklyn, Brooklyn, N. Y. 456 p., 6 × 9 in., bound. $5. This is the sixth volume in the Symposia Series of the Microwave Research Institute of the Polytechnic Institute of Brooklyn and the second volume devoted to nonlinear network theory. The technical papers are grouped by sessions devoted to recent progress in theory; circuit design; feedback systems; methods; and discontinuous systems.

Practical Automation
By Lester R. Bittel and others. 1957, McGraw-Hill Book Company, Inc., New York, N. Y. 376 p., 8¾ × 11¼ in., bound. $7.50. A practical guide to the installation and use of plant automation. In addition to the general discussions of fundamentals and specific recommendations for planning, operation, and management, over 150 actual cases, small and large, in existing plants, are described. The text material, profusely illustrated by photographs and diagrams, covers handling, processing, inspection, and maintenance operations, control instrumentation, communication systems, and computer applications.

Practical R. F. Heating for the Wood Industry
By J. Pound. 1957, Heywood & Company, Ltd., London, England. 198 p., 5½ × 8¾ in., bound. 30s. For the practical woodworker, this book presents information on radio frequency (R.F.) heating as used with adhesives in joining wood to wood. There is extensive treatment of transverse, glueline, and stray field heating. In addition to the manufacture of plywood, there are applications in furniture and boat-making. A chapter on other heating methods rounds out the text. There is a glossary and a bibliography for those who wish more theory on this subject.

Précis de Magnétoscopie
By E. A. W. Müller, 1957, Dunod, Paris, France. 169 p., 6¼ × 9½ in., paper. Fr. frcs. 1880. A French translation of a work by a German authority on magnetic testing of steel (flaw detection). Chapter 1 on principles deals with the magnetic field and its production, the use of magnetic powders, and the sensitivity of the method. Chapter 2 provides examples of applications to machine parts and welded joints, particularly some of the more difficult cases. The three subsequent chapters cover demagnetization, economic considerations, and literature references.

Précis de Métallographie Appliquée
By A. Roos. 1957, Dunod, Paris, France. 381 p., 6 × 9¾ in., bound. Fr. frcs., 4250. This "outline" of applied metallography begins with a general discussion of crystal structure. The following chapter deals with micrographic examination and metal testing. The general characteristics of binary alloys are discussed, leading to a consideration of phase diagrams and particularly the iron-carbon diagram. The metallographic aspects of heat treatment precede two chapters on the metallography of carbon steels and cast iron. The book ends with a brief treatment of research methods in the field.

Principles of Engineering Inspection
By Geoffrey K. King and C. T. Butler. 1957, Cleaver-Hume Press, Ltd., London, England, 264 p., 5¾ × 8¾ in., bound. 25s. A concise, practical treatment of equipment and methods of test for inspection in manufacturing, covering inspection of metallic and nonmetallic raw materials; forgings, casting, welds, and other types of primary production; machined components; and surface finish. The book also deals with the design and manufacture of gages, statistical quality control, and setting up an inspection system. Line drawings illustrate the working of the many testing machines described.

Probleme des Textilmaschinenbaues
VDI Berichte, Vol. 22. 1957, Verein Deutscher Ingenieure Verlag, Düsseldorf, Germany. 126 p., 8¼ × 11¾ in., paper. DM 24.20. A group of 17 papers on the construction of textile machinery presented at a meeting of the VDI Textile Engineering Division. Following four introductory papers on general or historical aspects, the remainder are included in five sections: spinning and threadmaking; weaving and preparatory operations; textile finishing; knitting and cordage; garment work.

Radioactivity and Nuclear Physics
By James M. Cork. Third Edition, 1957. D. Van Nostrand Company, Inc., Princeton, N. J. 415 p., 5½ × 8¾ in., bound. $7.75. Though prepared as a college text, this book may also serve as a useful handbook for workers in allied fields and a refresher for those reviewing present developments in the field. This edition brings discoveries in the nucleus of the atom up to date and describes advances in the design of accelerators and detectors. It also reviews the well-established domains of modern nuclear theory, and touches upon the history of radioactivity, natural and induced. The brief sketches on applications of radioactivity run the gamut of fields of scientific endeavor.

LIBRARY SERVICES

ENGINEERING Societies Library books may be borrowed by mail by ASME Members for a small handling charge. The Library also prepares bibliographies, maintains search and translation services, and can supply a photoprint or a microfilm copy of any items in its collection. Address inquiries to Ralph H. Phelps, Director, Engineering Societies Library, 29 West 39th Street, New York 18, N. Y.

Current Engineering Events, News, and Comment

E. S. NEWMAN
News Editor

THE ROUNDUP

1 A combination tilting table and tilting grinding head enables this tongue sander to perform on concave or convex contours. Contact wheels range in width from ¼ in. to 2 in., and may be yoked or yokeless. (Bush Mfg. Co.) **2** Extreme accuracy is obtained with a narrow coated abrasive belt on the Heim die polisher, which grinds and polishes contact surfaces of round-core extrusion and draw dies. Grit lines are parallel with the line of draw. (Hartford Special Machinery Co.) **3** A powered chuck keeps contoured work in contact with a coated abrasive belt formed by a shaped contact wheel. Substitution of a platen adapts the machine to flat surfaces. The chuck can be set to index automatically. (Divine Bros. Co.)

4

Fifty Manufacturers Exhibit at Third National Coated Abrasive Machinery Show

THE third National Coated Abrasive Machinery Show designed to keynote the growing importance of coated abrasives as a basic industrial tool, was held in Troy, N. Y., June 10 to 13. Several thousand industrial production men from all parts of the United States and six foreign countries viewed and tested 150 new abrasive machines selected to demonstrate developments of the past two years.

The Behr-Manning Company, a division of Norton Company, sponsored the show and acted as host to manufacturers who exhibited and to the machinery industry, at its new million-dollar Product Engineering building.

Production men representing all phases of the metalworking, woodworking, furniture, plastics, and other industries brought actual workpieces, using them to subject the new machines to comparative testing of their grinding and polishing performance. Among the 3000 visitors were large groups of supervisory men from grinding and polishing departments of large automobile manufacturers, aircraft firms, and government arsenals.

Among significant advances in machine-tool design, particularly among machines whose weight is measured in tons, was a conspicuous "beefing-up" of frames, bearings, and drive trains to keep pace with improvements in abrasive belts and with the increasing forces being exerted in heavy stock removal, descaling, and similar work. More attention was paid also to flooding the work areas with coolants, and to more thorough filtration to remove grinding swarf and other contaminants from the coolant flow—a benefit where close tolerances must be held in producing low micro-in. finishes.

Engineering education and training among many important topics considered at . . .

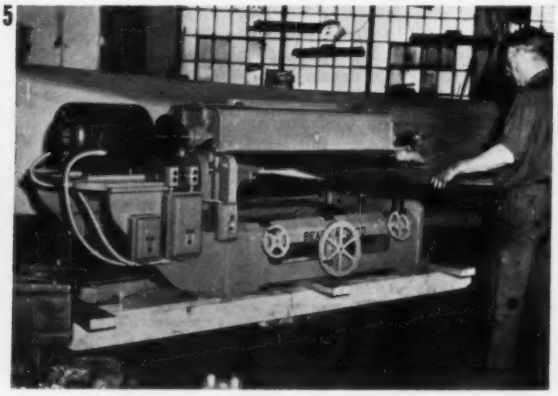
. . . First EUSEC Meeting in United States

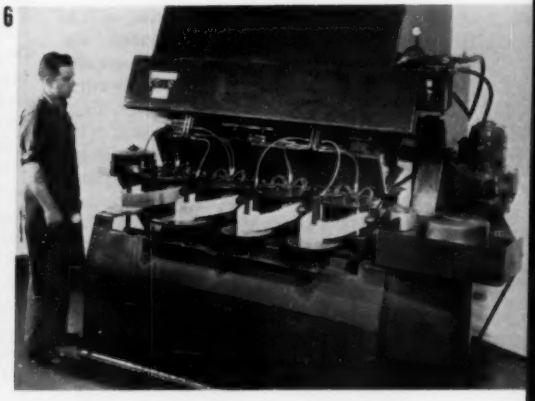
FOR the first time a conference of representatives of Engineering Societies of Western Europe and the United States (EUSEC) convened in the United States. The sixth conference of EUSEC was held in New York City, April 28–May 2, at the Hotel Roosevelt, with 45 delegates representing 23 engineering societies in 14 countries attending.

Following several years of preliminary ground work the three British engineering institutions in 1948 invited the presidents and secretaries of the national engineering societies of Europe and the United States to meet together in London to determine ways in which their organizations could co-operate in furthering the purposes of their organization. The meeting in October, 1948, was a success, and paved the way to a second meeting, again in London in September, 1949, at which a constitution and operating procedure were agreed upon. Since then conferences have been held in The Hague (1951), Paris (1953), and Copenhagen (1955).

In a warm welcome to the delegates attending the sixth conference, Louis R. Howson, ASCE President, said: "History has proved that engineering never has known boundaries. Our profession is such that our skills should not and, indeed, cannot be confined to one community, state, or nation. Members of the five American societies which I represent here are today working all over the world. The same is true of the societies and councils you represent in European countries. If there were boundaries, we would not be meeting here today. In fact, there would be no EUSEC. I am sure you will find American engineers as enthusiastic and energetic about EUSEC as their visitors from abroad. I welcome you to the United States and to the Sixth General Assembly of EUSEC."

4 On this heavy-duty centerless grinder, coated abrasive belts feed as well as grind the work. Traverse reversing eliminates returning long pieces to the infeed end of the machine, and powered fixtures drive rolls which aid in feeding heavy workpieces. (Production Machine Co.) **5** This machine polishes strip and tube stock longitudinally, indexing abrasive roll stock to a variable number of work points each of which is supported by a platen. Platens, pneumatically operated, oscillate parallel to work travel and, used in pairs, polish both sides of strip stock at feed speeds up to 50 fpm. (Kearsarge Engineering Corp.) **6** This precision two-drum flat sander produces close-tolerance work on wood, plastic, and metal. Work is held accurately between powered feed rolls while being supported on anvil rolls which extend slightly above table bed. Maximum drum length available is 54 in. (Beach Mfg. Co.)





Engineering Education and Training

Engineering education and training have been given the most active attention by EUSEC since its inception. Three assemblies have devoted attention to these important subjects. The Proceedings of the Third EUSEC Conference on Engineering Education held in Paris in September of 1957 are in print with special appendixes covering practices in Belgium, the United States, and the United Kingdom. In the Proceedings are reports from and appraisals of the methods followed in the participating countries. The subjects covered include: (1) A glossary of terms used in engineering education and training, (2) general education before admission to the university, (3) selection for admission to the engineering school, (4) education in the schools and universities, (5) postgraduate education and training, (6) practical training of the engineer, and (7) criteria for professional recognition.

Other Topics Considered

Other important topics given continuous consideration by EUSEC are: (1) abstracting and classifying engineering literature, (2) defining the terms "professional engineer" and "engineering technician," (3) fostering and facilitating the exchange of lecturers, (4) establishing reciprocal arrangements for extending professional courtesies to society members of one country visiting the country of another society, and (5) reporting on the supply of and the demand for engineers so that they may be utilized to their fullest capacity. All these subjects were on the New York conference agenda.

At the New York Conference Ove Guldberg, retiring General Secretary of EUSEC and Secretary of Dansk Ingeniorforening, formally transferred the management responsibilities of EUSEC to the U. S. A. societies. William H. Wisely, executive secretary of ASCE, was named General Secretary, and O. B. Schier, II, secretary of ASME, became Editor of the *EUSEC Bulletin*.

Two European engineering societies were admitted to EUSEC: Ordem dos Engenheiros de Portugal and the Instituto de Ingenieros Civiles de Espana, and the delegates from these societies were seated and participated in the deliberations of the conference.

Participants in the highly productive sixth EUSEC Conference, New York, N. Y., included representatives of 23 engineering societies in 14 countries, a fine example of international cooperation.

C. E. Davies Honored

At the closing dinner of the conference AIME President A. B. Kinzel summarized briefly the results of the conference and concluded with a series of toasts, each of which was followed by a response. Dr. Kinzel's final toast to "The Engineer" elicited a response by W. K. Brasher, secretary, Institution of Electrical Engineers (U. K.), who availed himself of the opportunity to award a testimonial gift and citation to C. E. Davies, who until recently was ASME Secretary, for his long and devoted service through EUSEC in the furtherance of international good will. Mr. Davies acknowledged this recognition with grace and deep sincerity.

Conference Participants

Participants in the New York conference of EUSEC include the following:

For Belgium, Société Royale Belge des Ingénieurs et des Industriels, Edmond Hianne, Secretary; Denmark, Dansk Ingeniorforening, Axel Kristensen, Authorized Deputy, and Ove Guldberg, Secretary; Finland, Samarbetsdelegationen i Finland (Joint Committee representing Suomen Teknillinen Seura and Tekniska Foreningen i Finland), Aulis Junttila, President, and R. S. Halonen, Secretary; France, Société des Ingénieurs Civils de France, Georges Ville, Secretary; Germany, Verein Deutscher Ingenieure, H. Grünewald, Secretary; Holland, Koninklijk Instituut van Ingenieurs, G. A. Tuyl Schuitemaker, President, and J. Ligthart, Secretary; Italy, Associazione Nacionale Ingegneri ed Architette Italiana, Andrea Ferrari-Toniolo, Secretary; Norway, Den Norske Ingeniorforening, Asbjorn Aass, President, and A. Nagell, Secretary; Portugal, Ordem dos Engenheiros, Jose Freire d'Andrade; Spain, Instituto de Ingenieros Civiles de España, José Vergara Doncel; Sweden, Svenska Teknologförening, John Faerden, President, Oskar Akerman, Secretary, and Sigvard Strandh, Special Deputy; Switzerland, Schweizerischer Ingenieur und Architekten Verein, Georg Gruner, President, and Pierre Soutter, Secretary; United Kingdom, The Institution of Civil Engineers, Arthur Whitaker, President, and Alexander McDonald, Secretary; The Institution of Mechanical Engineers, George Nelson, President, and Brian G. Robbins, Secretary; Institution of Electrical Engineers, T. E. Goldup, President, and W. K. Brasher, Secretary; United States of America, American Society of Civil Engineers, Louis R. Howson, President, and W. H. Wisely, Secretary; American Institute of Mining, Metallurgical and Petroleum Engineers, A. B. Kinsel, President, Joseph G. Gillson, Authorized Deputy, and E. O. Kirkendall, Secretary; The American Society of Mechanical Engineers, J. N. Landis, President, and O. B. Schier, II, Secretary; American Institute of Electrical Engineers, W. J. Barrett, President, Robert H. Barclay, Authorized Deputy, N. S. Hibshman, Secretary, and J. J. Anderson, Assistant Secretary; American Institute of Chemical Engineers, George R. Holbrook, President, Stephen J. Tyler, Authorized Deputy, and F. J. Van Antwerpen, Secretary; United Engineering Trustees, Inc., W. J. Barrett, President; Engineers' Council for Professional Development (U.S.A.), chairman, Morris D. Hooven, past-president, AIEE, and Chairman of U.S.A. Delegation to EUSEC Conference on Education and Training, Thorndike Saville; Engineers Joint Council (U.S.A.), Chairman, Enoch R. Needles, past-president, ASCE; Chairman of Committee on International Relations, Gail Hathaway; and Secretary of Engineering Manpower Commission and Secretary to EUSEC Working Party on Supply and Demand, William T. Cavanaugh.

Next EUSEC Conference

Invitation to hold the next conference in Brussels from the Société Royale Belge des Ingénieurs et des Industriels was accepted for September of 1960 or April of 1961 with exact date to be determined by the Advisory Committee which consists of Paul Bastien, Chairman; and William H. Wisely, Edmond Hianne, Ove Guldberg, A. Clifford Hartley, and H. Grunewald.

EDUCATION

Technical Paper Contest

To STIMULATE new ideas and to develop a top-quality program, the Annual Meeting Committee of the Standards Engineers Society is sponsoring a technical paper contest in conjunction with the society's annual meeting to be held September 22–24. An award of $50 will be presented to the author of the winning paper and it will be published later in *Standards Engineering*.

Rules for the contest are:

1 Papers must be concerned with some aspect of standardization, and should preferably be related to the theme of the meeting—"Standardization—A Must for the Space Age."

2 Papers should be 1600–2400 words in length.

3 Papers will be judged by the Awards Committee on the basis of content and originality.

4 The contest is open to anyone engaged in or interested in standards engineering.

5 In order to be considered, papers must be typed on one side of $8\frac{1}{2} \times 11$-in. paper, double spaced, submitted in quadruplicate, and postmarked not later than Aug. 1, 1958. They should be sent to Mr. E. D. Clark, 7th Standard Pressed Steel Company, Jenkintown, Pa.

Heat-Transfer Laboratory

THE Heat Transfer Laboratory of the Mechanical Engineering Department, University of Minnesota, announces a special course in Heat Transfer to be given from Aug. 7–15, 1958. The program will emphasize modern developments in heat transfer and is aimed at engineers and scientists working in the aircraft or missile field or in the nuclear power field. Such topics as Mass Transfer Cooling, Heat Transfer at High Altitudes, Radiation Properties of Gases at High Temperatures, Reactor Heat Transfer, Two-Phase Flow, and Boiling will be covered. Tuition for the course will be $180 and the enrollment is limited. Information may be obtained by writing to Dr. James P. Hartnett, Mechanical Engineering, University of Minnesota.

PEOPLE

New Officers. W. T. ALEXANDER, Mem. ASME, dean of engineering, Northeastern University, Boston, Mass., has been elected president of the American Society for Engineering Education. Others elected to principal offices were: C. L. ECKEL, Mem. ASME, dean of engineering, University of Colorado, vice-president in charge of regional activities in the western states; E. C. EASTON, dean of engineering, Rutgers University, New Brunswick, N. J., vice-president in charge of instructional divisions; JOHN GAMMELL, Affiliate ASME, Allis-Chalmers Manufacturing Company, Milwaukee, Wis., treasurer.

DETLEV W. BRONK, Hon. Mem. ASME, was re-elected to a four-year term, his third, as president of the National Academy of Sciences. He also heads the Rockefeller Institute.

H. S. KINDLER, Pittsburgh, Pa., has assumed direction of educational services on the national headquarters staff of the Instrument Society of America. He has until now been director of technical programs.

Campus Data. J. R. RAGAZZINI has been appointed dean of the college of engineering, New York University, New York, N. Y. Dr. Ragazzini who, is now chairman of the electrical engineering department at Columbia University, will assume his new duties on July 1, 1958.

LEWIS D. CONTA, Mem. ASME, professor of mechanical engineering and chairman of the Division of Engineering since 1950, has been named acting

New York City Officials Admire New United Engineering Center. The Greater New York Business Campaign for the new $10-million United Engineering Center got under way at a luncheon at the Waldorf-Astoria Hotel in May. City officials saluting the profession of engineering and warmly endorsing the campaign to fund construction of the new national headquarters included Mayor Robert F. Wagner, Commissioner Richard C. Patterson of the Department of Commerce and Public Events, and President of the City Council Abe Stark. Shown with model of the new Center are, *left to right,* John J. Theobold, Deputy Mayor; Commissioner Patterson; William H. Byrne, Chairman of the Greater New York Business Campaign; Mayor Wagner; Abe Stark; and C. F. Preusse, City Administrator. Mr. Byrne announced that major industrial corporations have contributed $3,079,200 since the industry drive opened last November, and with $2 million available from existing resource, the campaign has reached the half-way mark. The Founder Societies are asked to contribute according to membership; ASME's quota is $800,000.

ASME Members Meet in Tokyo. R. H. Bacon, *left,* Mem. ASME, Bacon's Clipping Bureau, Chicago, Ill., discusses the problems of Japanese industry with Tsutomu Arai, Mem. ASME, assistant director and manager, technical control department, Hatachi, Ltd., Tokyo, Japan. Mr. Bacon is presently on an air trip around the world. During his visit in Japan he had an opportunity to appraise Japanese industry and engineering industrialists' contributions toward the building of a new Japan.

dean of the new College of Engineering of the University of Rochester. The appointment is effective as of Sept. 1, 1958, when the present Division of Engineering becomes the College of Engineering.

Retirement. SENATOR RALPH E. FLANDERS, past-president and Hon. Mem. ASME, announced that he would not seek re-election as Republican Senator from Vermont. The Senator announced that he looked forward "to many things to do and see in the years to come."

COMING MEETINGS

Statistical Summer Seminar

THE ninth session of the Statistical Summer Seminar will be held July 28–Aug. 8, 1958, at the M.I.T. Endicott House, Dedham, Mass. This ONR-sponsored seminar is a private, nonprofit organization dedicated to exploring new areas of application in statistics.

"Tolerance Management" will be the subject of the July 28 to August 1 session. "Design of Industrial Experiments" will be discussed at a second session from August 4–8.

Familiarity through study and work in these statistical fields or professional competence in the field of application is assumed.

Further information may be obtained from Irving Weiss, Bell Telephone Laboratories, North Andover, Mass.

MEETINGS OF OTHER SOCIETIES

July 28–Aug. 1

Technical Association of the Pulp and Paper Industry, 13th engineering conference, Multnomah Hotel, Portland, Ore.

Aug. 10–16

National Academy of Sciences-National Research Council and the Radiation Research Institute, international congress of radiation research, Burlington, Vt.

Aug. 11–14

Society of Automotive Engineers, national West Coast meeting, Ambassador Hotel, Los Angeles, Calif.

Sept. 1–9

International Association for Analog Computation, second meeting, Strasbourg, France.

Sept. 16–20

Société des Radioélectriciens, international conference on nuclear electronics, UNESCO House, Paris, France.

(*For ASME Coming Events, see page 105*)

INDUSTRIAL FILMS

Films in Industry

A NEW 400-ft sound film of interest to those using motion pictures in business or education is available on loan from all Bell & Howell audio-visual dealers.

"Ideas and Film" is a color feature illustrating the various industrial applications of motion pictures. In producing this film, actual examples of the use of telephoto, microscopic, time-lapse, and high-speed cinematography were used. Included are unusually interesting sequences showing the shattering of a lamp bulb in slow motion, the action of a guided missile from launching to landing, the testing of a new automobile model, and an industrial time-and-motion analysis.

In addition to being available on loan from Bell & Howell audio-visual dealers, prints of the films may be purchased direct from the producing studios. The film is obtainable at $79.95 per print, color and sound, from Tele-Cine Film Studios, 100 South Northwest Highway, Park Ridge, Ill.

Lubricating Grease

"GREASE, the Magic Film," is the title of a comprehensive new movie just released to members of the National Lubricating Grease Institute. Designed by NLGI as a training aid for the industry, the 25-min color film in 16-mm sound will also be employed as a public-relations medium, for it stresses the need for proper lubrication in a series of filmed situations ranging from amphibious landing craft and airplanes to farm and road-construction equipment.

Hot or cold, high or low, wet or dry—whatever the conditions, there is a lubricating grease designed to do the job to provide that "magic film" so necessary for long life and low maintenance of moving parts, as shown in dynamic fashion throughout the movie.

Sustained in part by NLGI, it is a service for members of the Institute, and once initial distribution through these purchasers has been established, "Grease, the Magic Film," will be available at a nominal extra charge to nonmembers. Special prints adaptable for foreign language narration can also be obtained. Information about the film may be obtained from the National Lubricating Grease Institute, 4638 J. C. Nichols Parkway, Kansas City 12, Mo.

History of Technology to Be Assessed by New Society

In an effort to assess the impact of technology on society, a group of interested scholars have joined to form the Society for the History of Technology. The Society will sponsor meetings at which various aspects of technological history will be investigated and will publish a quarterly journal, *Technology and Culture*, devoted to the study of the development of technology and its relations with society and culture.

Executive Committee

The Executive Committee of the newly formed society consists of: Chairman, Melvin Kranzberg, Case Institute of Technology; Carl W. Condit, Northwestern University; Howard Mumford Jones, Harvard University; Edward Lurie, University of Michigan; Robert Multhauf, Smithsonian Institution; William Fielding Ogburn, University of Chicago; Stanley Pargellis, Newberry Library; John B. Rae, Massachusetts Institute of Technology; Richard Shryock, The Johns Hopkins University; Lynn White, Jr., Mills College.

Advisory Council

The Advisory Council is also in the process of formation and includes among its members: Robert Burlingame, West Redding, Connecticut; Leonard Carmichael, Smithsonian Institution; Charles W. Cole, Amherst College; Peter F. Drucker, New York University; George A. Gullette, North Carolina State College; Morrell Heald, Case Institute of Technology; Thomas B. Hughes, Washington and Lee University; Richard S. Kirby, Yale University; John A. Kouwenhoven, Barnard College; Thomas S. Kuhn, University of California; Philippe Le Corbeiller, Harvard University; Bert James Loewenberg, Sarah Lawrence College; Lenox R. Lohr, Museum of Science and Industry; Hugo A. Meier, Carnegie Institute of Technology; Theodore B. Merrill, Jr., *Business Week;* Robert K. Merton, Columbia University; Lewis Mumford, Amenia, New York; John U. Nef, University of Chicago; John W. Oliver, University of Pittsburgh; Derek J. Price, Institute for Advanced Study, Princeton, N. J.; David Riesman, University of Chicago; Robert E. Schofield, University of Kansas; Warren C. Scoville, University of California at Los Angeles; Thomas M. Smith, United States Air Force; Robert S. Woodbury, Massachusetts Institute of Technology.

Among the recent additions to the Advisory Council are Honorable Ralph E. Flanders, past-president and Hon. Mem. ASME, United States Senate; Elting E. Morison, Massachusetts Institute of Technology; Duane H. D. Roller, University of Oklahoma; Abbott Payson Usher, Salem, Massachusetts; David B. Stout, State University of Iowa; Mervin J. Kelly, Bell Telephone Laboratories, Inc.

As its first program, the society will co-sponsor the meeting of the Humanistic-Social Division of the American Society for Engineering Education, to be held at the University of California, Berkeley, on June 16–17. The program is as follows:

June 16: The Role of the Technical Museum in Engineering Education, by *Robert Multhauf*, head curator, Science and Technology, Smithsonian Institution.

Engineering Concepts in the Development of Thermodynamics, by *T. S. Kuhn*, University of California.

June 17: Relations of Science, Technology, and Art in Nineteenth Century Building, by *C. W. Condit*, Northwestern University.

Technology and Cultural Values in American History, by *Edward Lurie*, University of Michigan.

Publication Plans

The Society expects to begin publication of *Technology and Culture* in the Fall of 1959. Applications for charter membership ($10) in the Society for the History of Technology should be sent to Prof. Melvin Kranzberg, Room 315, Main Building, Case Institute of Technology, Cleveland 6, Ohio.

How Long Is Time? Science Wants to Know

Experiments capable of bringing a new degree of accuracy to man's concepts of time and the nature of the universe were described at a meeting in Asbury Park, N. J., May 6–8.

One line of research, which soon will be in progress at a number of laboratories, might help to determine whether the universe had a beginning, and therefore will have an end.

Other experiments described point to ways of dealing with some aspects of Einstein's theories of relativity that still have not been entirely proven.

The possible lines of research were reviewed by Charles M. Townes, a physicist of Columbia University. He spoke at the Berkeley-Carteret Hotel at a final session of the twelfth annual electronics symposium sponsored by the Army Signal Engineering Laboratories at Fort Monmouth.

The three-day meeting, which ended May 8, had been attended by scientists from this country and abroad who specialize in research concerned with highly precise measurements of time and of radiation frequencies.

Satellite Tests Cited

Dr. Townes noted that the group of experiments he described had become possible only with the development of "atomic clocks" that permit time measurements to accuracies better than one part in a billion. Some of the experiments also would require the use of earth satellites.

The widely held view that the universe began in a giant primordial explosion 6,000,000,000 years ago or more is based on experiments that seem to show the universe is expanding. Evidence for this is the so-called red shift—an apparent distortion of the spectrum of light from very distant stars, which indicates that the source of light is moving rapidly away from us.

An alternative explanation for this shift is that the light is billions of years old and that the atomic constants by which such things are measured on earth have changed during the interval. If this is true, the universe might not be expanding and therefore might not have been "born" in a single cataclysm.

Behavior of Time

It may be possible to prove or disprove the second hypothesis by a comparison of a gravitational constant, the rotation of the moon, with atomic constants now available to modern physics. Such an experiment would take about five years, Dr. Townes estimated.

A project along these lines has been undertaken jointly, he noted, by Britain's National Physical Laboratory and the United States Naval Observatory. It will soon be tried at several other laboratories.

In an experiment requiring an earth satellite it might be possible to examine the behavior of time in a gravitational field by comparing a highly precise time-measuring device on earth with one high above earth, where gravitational effects would be different. Such a gravitational effect on time is a fundamental result of the General Relativity Theory, but has not been clearly tested, the speaker pointed out.

Notes on Society Activities and Events

E. S. NEWMAN
News Editor

THE ASME NEWS

The program, both technical and social, is shaping up for a big event . . .

. . . THE 1958 ASME PETROLEUM CONFERENCE

MILE-HIGH Denver, Colo., gateway to the Rocky Mountains, marks the scene for the 1958 Conference, Petroleum Division of The American Society of Mechanical Engineers. The conference opens with registration September 21 in the Cosmopolitan Hotel. It closes Wednesday afternoon, September 24.

Denver, Hub of Oil Operations

Denver was chosen as the 1958 conference site because it is the hub of vast oil operations in the Rocky Mountain empire. In Colorado alone in the last ten years, annual well completions have risen 300 per cent. In 1947, only 209 wells were completed. But in 1957, 855 were completed. These 855 wells include 540 wildcat wells drilled in 39 counties. In the Denver Metropolitan area are five refineries with a combined capacity of 32,450 bbl per day.

The Cosmopolitan Hotel is Denver's largest with 425 rooms. It is located on the main North-South thoroughfare. Many of the rooms are air-conditioned. Most feature television. All give an impressive view of bustling downtown Denver. The Rocky Mountains form an impressive western sky line. A motor lobby with its own entrance and adjoining parking areas provide welcome convenience for motoring guests.

All meeting rooms at the Cosmopolitan are conveniently located on the mezzanine, with two exceptions—the Silver Glade and Board rooms.

Conference attendees can make arrangements at the hotel for tours of Denver and the surrounding area, including the Denver mountain parks.

Technical Sessions

The four-day Petroleum Division conference will feature about 45 technical papers and several panel discussions. Papers will cover the mechanical-engineering aspects and latest developments for pipelining, drilling, production, refining, and petrochemical manufacture.

The Drilling-Production Committee plans to hold about six sessions and a panel discussion. Papers will give the latest developments in pumps and pipe-handling equipment. Others will explain what is going on in drilling and production research. A joint panel with the Transportation Committee will discuss production and pipeline requirements for automatic custody transfer of oil and legal problems facing users of LACT units.

Reports on plastic packings, turbodrills, and tubing calipers are among the papers planned by the Manufacturers Committee. The Materials Committee expects to present seven papers. These will include data on high-strength ceramic materials and their value to the petroleum industry, paints to protect equipment from salt-water corrosion, and the results of recent studies on pipeline welding and on the chemical and physical properties of line pipe.

The Transportation Committee plans ten papers and the joint panel on automatic custody transfer with the drilling-production committee. They also plan a

Frank Campbell, *left,* and R. C. Hadley are busy mapping plans for 1958 ASME Petroleum Conference to be held at the Cosmopolitan Hotel, Denver, Colo., September 21–24. Mr. Campbell, Colorado School of Mines, is vice-chairman and Mr. Hadley, Stearns-Roger Manufacturing Company, is chairman of the Denver General Arrangements Committee.

symposium on ways in which computers are being used by oil and gas pipeline companies. They will also go into the engineering required for a 56-in-diam gas pipeline, the value of torque control on engine-driven gas compressors, how to control pipe stress in underwater pipelines, new developments in pipe connections, and recent developments in oil metering.

The Refining, Gas Products, and Petrochemical Committee plans 12 papers. They also plan three panel discussions. These will go into the ASME Pressure Vessel and Piping Codes, and the design and use of field compressors. Papers will go into the design of pressure vessels, procurement, evaluation, and development of engineers, and how to use brainstorming to promote creative thinking.

A symposium will also discuss the applications and design of plastic pipe in refineries and petrochemical plants.

Registration Is a Snap

Convenient registrations are planned for conference attendees. The registration desk will be open on Sunday, September 21, from 3:00 to 7:00 p.m. Then on Monday three registration lines will be operating. One will be for those registering in advance. They can pick up tickets and name tags conveniently. Two other lines will allow those not registering in advance to do so with the least possible inconvenience.

A variety of entertainment is planned. Sunday evening the film, "One Mile Closer to Heaven," sponsored by the Denver Chamber of Commerce, will be shown. This is an outstanding film about Denver. On Monday at a noon luncheon, a representative of the Denver Mayor's office will formally welcome registrants to the city. Then on Tuesday evening at a banquet, Edward Barclay Wilcox, an authority on Russian communism, will speak on communism's threat to the oil supply in the Middle East. During the social hour and banquet, dinner music will be provided by one of Colorado's prominent musicians, Leonard Baylinson.

ASME-AIChE Heat Transfer Conference and Exhibit to Be Held in Chicago, August 18–21

THE second national Heat Transfer Conference and Exhibit, sponsored jointly by The American Society of Mechanical Engineers and the American Institute of Chemical Engineers, will be held Aug. 18–21, 1958, at the Edgewater Beach Hotel, Chicago, Ill.

The technical program for the three-day conference on the theoretical and practical aspects of heat transfer will be presented at 12 sessions and includes 48 papers by some of the leading authorities in the field. The papers will be preprinted and will be part of the registration fee of $15 to members of either society or $25 to nonmembers. The exhibit will include the latest heat-transfer equipment, media, and ancillaries.

The tentative technical program is as follows:

▶MONDAY, AUGUST 18

Session 1 — 9:30 a.m.

The Design of Heating Coils for Storage Tanks, by *D. Stuhlberg*

The Pressure Drop of Condensing Steam in Horizontal Pipes, by *R. J. Dunn* and *D. Stuhlberg*

Heat-Exchanger Maintenance as Influenced by Design and Economic Factors, by *G. T. Atkins* and *N. O. Felps*

Production Heat-Transfer Problems Solved by Gas, by *C. P. Mann*

Session 2 — 9:30 a.m.

Heat and Mass Transfer From a Rotating Disk, by *F. Kreith, J. H. Taylor,* and *J. P. Chong*

Transient Heat Conduction in Elliptical Plates and Cylinders, by *E. T. Kirkpatrick* and *W. F. Stokey*

Transient Heat Conduction in Annular Fins of Uniform Thickness, by *A. J. Chapman*

The Radial Heat Flux, by *S. W. Churchill* and *R. E. Balzhiser*

A Note on Latent Heat in Digital Computer Calculations, by *G. M. Dusinberre*

Session 3 — 2:30 p.m.

Heat Transfer and Pressure Drop of Air in Forced Convection Across Triangular Pitch Banks of Finned Tubes, by *D. J. Ward* and *E. H. Young*

Engineering Method for Determining a Design Envelope for Air-to-Air Cross-Flow Heat Exchanger, by *W. T. Shatzer*

Optimum Air-Fin Cooler Design, by *D. Q. Kern*

Calculation of Transients in a Cross-Flow Heat Exchanger, by *G. M. Dusinberre*

Russian Vocabulary for Heat Transfer Literature, by *(Mrs.) F. F. Buckland*

Session 4 — 2:30 p.m.

Film Coefficients for Heat Transfer to Liquid Drops, by *E. R. Elzinga, Jr.,* and *J. T. Banchero*

A Correlation of Rotary Drum Cooler-Flaker Heat Transfer, by *K. L. Mai*

Numerical and Machine Solutions of Transient Heat-Conduction Problems Involving Melting or Freezing, Part 1, by *W. D. Murray* and *F. Landis*

Experimental Forced Convection Heat Transfer With Adiabatic Walls and Internal-Heat Generation in a Liquid Metal, by *G. L. Muller*

Heat-Transfer Coefficients Observed in Small Sodium Exchangers, by *S. C. Hyman*

▶TUESDAY, AUGUST 19

Session 5 — 9:30 a.m.

Heat Transfer and Fluid Friction During Flow Across Banks of Tubes-VII—Fluid Bypassing Between Tube Bundle and Shell, by *O. P. Bergelin, K. J. Bell,* and *M. D. Leighton*

Local Shell-Side Heat-Transfer Coefficients in the Vicinity of Segmental Baffles in Tubular Heat Exchangers, by *M. S. Gurushankariah* and *J. G. Knudsen*

Description and Experimental Results of Two Regenerative Heat Exchangers, by *E. K. Dabora, M. P. Moyle, R. Phillips, J. A. Nicholls,* and *P. L. Jackson*

Two-Phase Pressure Drop for Horizontal Cross-flow Through Tube Banks, by *J. E. Diehl* and *C. H. Unruh*

Session 6 — 9:30 a.m.

Radiant Heat Transfer in Sheet Annealing Furnaces, by *H. T. Bates* and *T. Utsumi*

Radiative and Conductive Heat Transfer in a Quiescent Gas-Solid Bed of Particles; Theory and Experiment, by *F. B. Hill* and *R. H. Wilhelm*

Heat and Mass-Transfer Coefficients for the System Air-Water, by *W. S. Stewart* and *R. L. Huntington*

Emissivity Measurements of Industrial Surfaces Due to Thermal Radiation, by *M. N. Aref*

Session 7 — 2:30 p.m.

The Prediction of Surface Temperatures at Incipient Boiling, by *S. G. Bankoff*

Design of High Velocity Forced Circulation Reboilers for Fouling Service, by *W. A. Chantry* and *D. M. Church*

Generalized Correlation of Boiling Heat Transfer, by *S. Levy*

Heat Transfer to a Boiling Liquid: Mechanism and Correlation, by *K. Forester* and *R. Grief*

Heat Transfer to Boiling Freon in a Vertical Tube, by *H. L. Foltz* and *R. G. Murray*

Session 8 — 2:30 p.m.

Heat Transfer in a Vacuum-Tube Amplifier, by *M. Goldberg*

The Use of Steady-State Electrical Network Analysis in Solving Heat-Flow Problems, by *A. D. Kraus*

The Effectiveness of a Transistor Cap as a Heat Dissipator, by *A. D. Kraus*

Natural Convection in Horizontal Liquid Layers, by *I. E. Schmidt* and *P. L. Silveston*

▶WEDNESDAY, AUGUST 20

Session 9 — 9:30 a.m.

Bubble Growth Rates in Highly Subcooled Nucleate Boiling, by *S. G. Bankoff* and *R. D. Mikesell*

Active Sites for Nucleate Boiling, by *H. B. Clark, P. S. Strenge,* and *J. W. Westwater*

Void Volumes in Subcooled Boiling Systems, by *P. Griffith, J. A. Clark,* and *W. M. Rohsenow*

Nucleate Boiling—A Correlation, by *C. H. Gilmour*

Session 10 — 9:30 a.m.

The Effects of Superimposed Forced and Free Convection in Horizontal and Vertical Rectangular Ducts, by *M. Altman* and *F. W. Staub*

Heat Transfer From Isothermal Flat Plates—An Extension of Pohlhausen's Solution to Low and High Prandtl Number Fluids, by *F. D. Fisher* and *J. G. Knudsen*

Free Convection, Forced Convection, and Acoustic Vibrations in a Constant Temperature Vertical Tube, by *T. W. Jackson, W. B. Harrison,* and *W. C. Boteler*

Transient Heat Transfer for Forced Convection in the Thermal Entrance Region of Flat Ducts, by *R. Siegel* and *E. M. Sparrow*

The Effect of Natural Convection Upon Heat Transfer at High Reynolds Numbers, by *H. T. Bates* and *A. I. Munaim*

Session 11 — 2:30 p.m.

Mechanically Aided Heat Transfer, by *D. Q. Kern* and *H. J. Karakas*

Heat-Transfer Aspects of Concentrated Milk in a Falling Film Evaporator, by *J. F. Keville*

A Preliminary Study of Boiling Burnout Heat Fluxes for Water in Vortex Flow, by *W. R. Gambill* and *N. D. Greene*

Performance of Vaporizers—Analysis of Plan Data, by *C. H. Gilmour*

Session 12 — 2:30 p.m.

Condensing Heat Transfer Within Horizontal Tubes, by *W. W. Akers, H. A. Deans,* and *O. K. Crosser*

Forced Convection, Local Boiling Heat Tranfer in Narrow Annuli, by *L. Bernath* and *W. Begell*

Methods of Improving Heat Transfer in Evaporators of Small Thermocompression Sea-Water Stills, by *J. A. Eibling* and *D. L. Hyatt*

Heat Transfer to Water in Thin Rectangular Channels, by *S. Levy, R. A. Fuller,* and *R. O. Niemi*

Technical Sessions and Inspection Trips Mark Pattern of Thirtieth Annual Conference in Philadelphia

OIL AND GAS POWER CONFERENCE

More than 400 attended the thirtieth annual Conference and Exhibit of the Oil and Gas Power Division of The American Society of Mechanical Engineers which was held in Philadelphia, Pa., May 12–15, 1958. The schedule of events included a broad technical program, inspection trips to a refinery and a gas-turbine production plant, and a Philadelphia Section party. The four-day program was highlighted by panel discussions and the OGP Conference banquet and luncheon stamped the proceedings first-rate.

Luncheon and Banquet

Welcome remarks were delivered at the luncheon on Monday by Arthur W. Weber, Vice-President of ASME Region III, and vice-president of engineering and manufacturing of the Corning Glass Works, Corning, N. Y. Keeton Arnett, executive vice-president, Greater Philadelphia Chamber of Commerce, spoke of the merits of the Philadelphia area as a manufacturing and engineering center.

L. M. Goldsmith, Fellow ASME, general manager of engineering and construction, The Atlantic Refining Company, Philadelphia, Pa., served as toastmaster and introduced the luncheon speaker, James Creese, Affiliate ASME, president of his alma mater, the Drexel Institute of Technology.

President Creese commented that "any institution should be proud of the program you have arranged," which not only affords an opportunity for the representatives of industrial concerns, research organizations, and academic institutions to meet and discuss common problems, but "indicates the areas in which future research will be done. One gets a little confused these days," he stated, "in deciding on which side of the fence he belongs. The lines have been blurred between college or university and industry, but all are involved in the production of the greatest number of qualified people for the critically important work of today."

"Just to keep an academic atmosphere in this reappraisal of today's needs," Dr. Creese cited a few of the works that have had a formative influence on educational policy. He also spoke of the recent comparisons that have been made with the more traditional approaches of the British, Scottish, and Scandinavian universities, pointing out the great contribution the latter have made through the Nobel prize with which they have begun a "creative approach to international affairs."

ASME Vice-President Arthur W. Weber was toastmaster at the Banquet. Louis L. Otto, Mem. ASME, and chairman of the OGP committee on awards introduced the ASME members receiving various honors. Election of Louis N. Rowley, Jr., executive editor of *Power*, and John A. Worthington, manager of the piston ring and seal department, Metal Products Division, Koppers Company, Inc., to the grade of Fellow was announced.

OGP Citations were given to: B. P. Emerson, editor of *Diesel Power*, for his service on the Executive Committee and as Division secretary; Hewitt A. Gehres, executive vice-president, Cooper-Bessemer Corporation, for his professional accomplishments including a variable-pitch propeller which he devised for use with diesels, work on fuel-injection systems, and pioneering work on the free-piston engine; James C. Barnaby, consulting engineer, Worthington Corporation, for his contributions to marine diesel applications, and efforts in the promotion of spark-ignition engines.

Some principal OGP figures are, *left to right*, Division Chairman E. L. Dahlund, Mem. ASME; Toastmaster L. M. Goldsmith, Fellow ASME; Alfred J. Buchi of Winterthur, Switzerland, Life Mem. ASME; Alfred J. Buchi, Jr.; R. Tom Sawyer, Fellow ASME; and W. M. Kauffmann, Assoc. Mem. ASME.

The OGP Speaker's Award was presented to J. D. Hines, Mem. ASME, chief research engineer, and Nelson Reed, designer of rotating machinery, the Cooper-Bessemer Corporation, for the best paper presented at last year's conference, "Turbocharger Development for Loop-Scavenged Two-Cycle Gas Engines."

All honors and awards were presented by ASME President James N. Landis, vice-president, Bechtel Corporation, who delivered a few remarks, limited in length in order not to take time from the Banquet Address. "The Oil and Gas Power Division," he stated, "is a venerable and wise organization. We are doing a new thing in the ASME in swinging over from regional and general meetings to Division conferences. I say this is a new thing, but OGP started this 30 years ago. You were 30 years ahead of the rest of the Society. You have been ahead and if your goal is to remain in the forefront of the Society, I am sure you will achieve it."

A. G. Mumma, chief of the U. S. Navy Bureau of Ships delivered the Banquet Address on "The New Navy." Admiral Mumma stated that, in the interest of achieving and maintaining military superiority, the Navy has pioneered many new technical developments. All the military forces are specialists in transportation of one kind or another. The Navy has specialized in bulk transportation by ship, and 99 per cent of the cargo that traverses the oceans, he stated, still travels that way. Transportation costs are a fraction of a cent a ton mile for bulk cargo such as oil or lumber, and range upward for other commodities to 35, 40, or maybe 50 cents a ton mile for passengers. Into this transportation picture fall submarines, ships, and of course, Naval air transport.

There is a popular misconception, Admiral Mumma stated, that the surface of the ocean is no longer tenable. The Navy doesn't think so. It is no more true than stating that the surface of the land is untenable, and the mobility of sea forces makes the problem simpler there. The ability of submarines to travel far and fast under water is unquestioned, but the bulk of Naval transportation must be on the surface for economy reasons since costs jump 6 to 25 times when surface operations are transferred to submarines.

The Navy is continuing to develop new sources of power for its vessels. If the current naval-construction bill is approved, 32 nuclear-powered ships will be built, building, or authorized. Nuclear power will be applied first to submarines where it conveys the most advantages in time between fuelings and surfacings required, plus the very potent ingredients of stealth and deceptiveness. Even for a carrier, the ability to stay at sea is important, but this advantage of nuclear power will have to be balanced against cost. Economics will govern which forms of power are applied to various uses. No means of transportation has ever gone completely out of existence. Even the oxcart is still used where it remains economically competitive.

In applying economics to the cost of transportation, protective and offensive missiles have high priority in spite of the fact that it costs hundreds and even thousands of dollars a ton mile to carry them. This high cost, Admiral Mumma stated, guarantees that they will not be used for "brush fires" such as the recent war in Korea may have been. Thus economics enters into even the selection of weapons. Still we must not be defenseless even against the nibbling kind of war which is probably going to be "the pattern from now henceforward to nibble us to death in all the fringes and perimeters of the free world."

The role of the New Navy is to be as modern as it is possible to be. The frontiers of science must be pushed out, whether they be nuclear power, missiles, or whatever new advance that could be of help. Research and development are extremely important and must be kept moving if we are to continue this fantastic story of progress that has made our Navy and our country so great.

Technical Sessions

Two panel discussions on maintenance problems, several papers on engine and component design, and diesel fuels, performance, and lubrication techniques, a method of charge stratification for spark-ignition engines, and a survey of free-piston-engine possibilities, were the principal technical session topics.

The panel discussions were on the "Maintenance of Fuel-Injection Systems," and "What Happens to Turbochargers." Design considerations were barred from both panels with emphasis placed on maintenance.

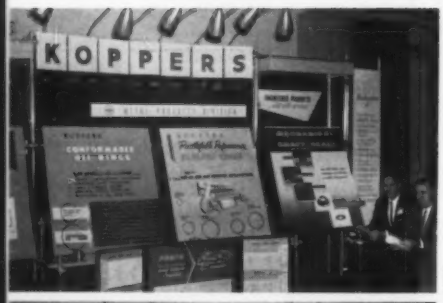
Fuel-Injection Systems. The discussion on fuel-injection systems was subdivided into: (*a*) symptoms and diagnosis, (*b*) prevention, and (*c*) do-it-yourself. A basic disagreement between two of the representatives of manufacturers developed at the start. One maintained that nozzles should be left alone until trouble develops, little being gained by taking them out and "looking at them." The other advocated a periodic removal and cleaning. Following use of a TU-2 solvent, careful polishing with a light crocus cloth avoiding scratching that would permit build-up of "whiskers," and the use of a copper-tipped music wire of 0.001 in. less in diameter than the orifice were advocated for cleaning.

Inspection of orifices only 0.006 in. in diam is difficult, but a mirror-concentrating and reflecting device is available. Air or oil testing of the holes can also be applied.

Authors of papers on Navy diesel-engine development, *left to right in left photo,* Albert C. Cavileer; Anker K. Antonsen, Mem. ASME; J. H. Reinertson, Mem. ASME; and Session Chairman Dean A. Horn. *Center photo,* L. N. Rowley is presented to ASME President James N. Landis by L. L. Otto, *in background,* for Certification of promotion to Fellow grade. Banquet speaker, *right photo,* Rear Admiral A. G. Mumma, Chief of the U. S. Navy Bureau of Ships.

Oil and Gas Power Conference

and Exhibit



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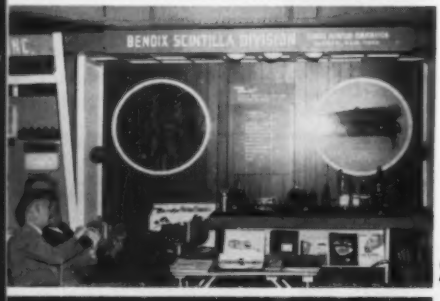

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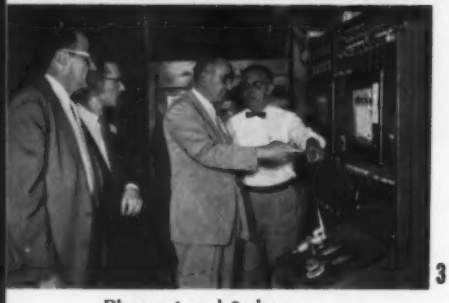

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Photos 1 and 2 show Koppers and Bendix booths at OGP Exhibit. 3. During tour of industrial gas-turbine department and development laboratory at Westinghouse Steam Division plant, E. J. Fogel, *extreme right,* manager, industrial gas-turbine manufacturing, tells OGP visitors about control center for testing 5000-kw gas turbines. *Below:* G. W. Ferguson, The Texas Company, Beacon, N. Y., points out a huge industrial gas-turbine rotor to Robert Cramer, Jr., of Nordberg Manufacturing Company, Milwaukee, Wis.

Lapping of the nozzle seat was recommended for Bosch nozzles but not for Bendix nozzles. The former are through-hardened and the casing will be penetrated if they are ground too much. The latter are too hard for grinding. Since sealing is accomplished by the use of a 1-deg differential, lapping must be done with extreme care.

The importance of filtration for preventing trouble was emphasized, but much can be done with standardization of filters. The Pennsylvania Railroad has 42 styles of filters but is planning to standardize on two, one for pump protection, and a second for not more than 5-micron particles, and having a service life of one year. Anticipation of trouble is the basis of their nozzle maintenance.

The do-it-yourself part of the discussion narrowed to some suggested criteria. If $5000 for injection-overhaul tool-up, plus $15,000 for pump-overhaul tool-up are available, plus the ability to adhere to manufacturer's tolerances, plus the feasibility of long-range employment of trained mechanics—do-it-yourself!

Turbochargers. Good operation of turbochargers, as discussed by the other panel, is a complex matter. Several elementary points should not be overlooked, particularly the use of large enough muffling and exhaust piping even though these may seem disproportionate to the size of the equipment, and the avoidance of the use of turbochargers as the support for piping.

Special and temperature controls can minimize the amount of overfueling. A pressure-ratio controller and aneroid compensators can be used to regulate the output from the turbocharger compressor and to maintain constant turbocharger speed in spite of changes in ambient temperature or altitude. More and more controls are being devised for efficient and transient-free operation. Air and oil filtration are important, and low or delayed oil pressure can cause many problems.

The use of ultrasonic cleaning techniques has its limitations. They work well for soluble materials, but are not too satisfactory for hard-carbon deposits.

Navy Diesels. Two diesel engines for Naval service were the topic of papers. One engine was first proposed by Anker K. Antonsen at the 1955 OGP conference and has been brought to satisfactory completion through the co-operative efforts of the Bureau of Ships, the U. S. Naval Experiment Station, and Fairbanks-Morse, the contractor. One of the first engines specifically designed for snorkel operation, it is of the opposed-piston type and required an ultimate rating of 1500 hp at 1500 rpm.

The other engine was for both snorkel and surface-ship operation. Specific weight had to be one half that of commercially available engines with a 3600-bhp 900-rpm rating. A completely new design was developed, tested, and applied.

The theoretical and practical considerations that have been applied to produce today's turbocharged uniflow two-cycle spark-ignited gas engine were the topic of another paper.

Component Design. Component-design papers covered the development of a method of charge stratification for spark-ignition engines, a telescope-valve system for four-cycle diesel engines, and the design of a diesel governor. The charge-stratification method utilizes a small auxiliary side chamber in which the ignition of a richer mixer serves to ignite the leaner mixture in the main combustion chamber to achieve greater fuel economy at light load.

The new telescope-valve system with its specially designed cylinder head, combustion chambers, valves, fuel-injection system, and valve-control mechanism although developed for diesel engines can be adapted to any size and type of internal-combustion engine.

The paper on governor design, in addition to stating several principles that are applicable to all dashpot-type governors, gave a detailed development of the design of a specific isochronous governor that was to be half the size of the smallest governor previously manufactured by the company.

Lubrication. The papers on lubrication included a progress report on a development program for large-diesel-cylinder lubricants, an account of the development of two specific lubricants for the pistons and cylinders of large marine and stationary diesel engines burning heavy fuels, and a review of the lubrication problems for diesel engines required to operate in arctic temperatures below −35 F, including the use of a special starting engine.

Filters. The type of filters, various filtration media, and the selection and installation of filters on diesel, dual-fuel, and gas-burning stationary and marine engines were the topic of another paper.

It was discovered in a study of the performance of economy diesel fuels in railroad use that performance cannot be predicted on the basis of physical properties alone. The combination of fuel-rack setting and injection timing for optimum fuel economy are different for each fuel.

The possibilities, performance, and operation of the free-piston engine, particularly the Model GS 34, which

incorporates the diesel cycle and some elements of the conventional gas-turbine cycle were surveyed in a paper presented for A. F. Moiroux of the Société d'Etudes Mécaniques et Energétiques, SEMESIGMA.

Exhibits and Inspection Trips

The exhibits, which are regarded as a particularly important part of an OGP Conference and Exhibit were installed by 27 companies representing engine, instrument, filter, governor, metals, drive, and lubricant manufacturers. The exhibitors also held social hours for all attending the conference, following the morning sessions and preceding the Banquet.

Inspection trips were taken to the Atlantic Refining Company and the Westinghouse Gas-Turbine Plant. The research and development laboratories were a part of the visits to both companies. At the Westinghouse plant, large commercial gas turbines were seen under construction and in actual test operation.

Availability List: ASME Oil and Gas Power Conference Papers

THE papers in this list are available in separate copy form until March 1, 1959. Please order only by paper number; otherwise the order will be returned. Copies of these papers may be obtained from the ASME Order Department, 29 West 39th Street, New York, N. Y. Papers are priced at 25 cents each to members; 50 cents to nonmembers.

58—OGP-1 Arctic Lubrication of Diesel Engines, by E. J. Beck, Jr.

58—OGP-2 Development of a Lightweight, High-Output Four-Cycle Diesel Engine for Naval Service, by L. Wechsler and H. Holler

58—OGP-3 Lubrication of Large Diesel Cylinders, by J. E. Cox and P. D. Hobson

58—OGP-4 The Filtration of Diesel Engine Oils, by J. R. McCoy

58—OGP-5 A Method of Charge Stratification for Four-Stroke-Cycle Spark-Ignition Engines, by L. D. Conta and P. Durbetaki

58—OGP-6 The Contractor's Part in the Development of a Diesel Engine for the U. S. Navy, by A. K. Antonsen

58—OGP-7 The Free-Piston-Engine Possibilities, by A. F. Moiroux

58—OGP-8 The U. S. Naval Engineering Experiment Station's Part in the Development of a Diesel Engine for the United States Navy, by A. C. Cavileer

58—OGP-9 The Bureau of Ship's Part in the Development of a Diesel Engine for the United States Navy, by J. H. Reinertson

58—OGP-10 The Buchi-Telescope-Valve System on Four-Cycle Diesel Engines, by A. J. Buchi

58—OGP-11 Scientific Design of a Diesel Governor, by A. G. Massey and R. Oldenburger

58—OGP-12 Development of a Turbocharged Uniform Two-Cycle, Spark-Ignition Gas Engine, by W. M. Kauffmann

58—OGP-13 A New Look at Diesel Lubrication, by J. V. Kalb and S. M. Pier

58—OGP-14 Performance of Economy Diesel Fuels in a Railroad Locomotive-Type Diesel Engine, by T. A. Kramer and D. P. Osterhout, Jr.

Symposium on Naval Structural Mechanics to Have ONR and Stanford Sponsorship

AN unclassified symposium on Naval Structural Mechanics, under the joint sponsorship of the Office of Naval Research and Stanford University, will be conducted at Stanford University, Stanford, Calif., from August 11 through 14. First of a series to be held at the University, this symposium has the purpose of providing an over-all critical review of those broad topics which are basic to the Navy's interest in structural mechanics and closely allied research areas.

A formal program, to be issued shortly by Stanford University, indicates that the symposium will consist of presentation of invited critical surveys, rather than individual research papers. The tentative list of subjects to be covered includes: linear and nonlinear elasticity, plasticity, thermal stress and deformation, residual stress, structural instability, then shells, vibration and impact, stress wave propagation, structure-borne noise, mechanism of deformation and failure, rheology, new materials, aerohydroelasticity, photoelasticity and photoplasticity, instrumentation, and computers.

Speakers are to be selected from among the nation's leading scientists in these fields.

The symposium, which will present the broadest scientific coverage of these subjects to date, is expected to provide realistic guidelines for the Navy's research program in structural mechanics, to assist in publicizing the vital nature of the Navy's interest in the subjects listed, and to attract the additional efforts of competent scientists in related areas of research.

All interested persons are invited to attend. Correspondence may be addressed to the joint chairmen; either Prof. J. N. Goodier, or Prof. N. J. Hoff, Stanford University, Stanford, Calif.

Copies of the program, with information as to housing and so on, may be had by writing to Mrs. Charlotte Harris, Timoshenko Laboratory, Stanford University, Stanford, Calif.

ANS CHOOSES CHICAGO FOR NEW HEADQUARTERS

CHICAGO, where man first unleased and controlled the power within the atom in 1942, soon will be the home of the only professional society concerned with the entire field of atomic science and engineering exclusively.

The fast growing American Nuclear Society, incorporated in New York City in 1955, will move its headquarters on July 1 from Oak Ridge, Tenn., to the John Crerar Library, Chicago, Ill.

Listed among the largest technical libraries, the Crerar Library is designated as an official U. S. Atomic Energy Commission repository for literature on atomic energy.

The announcement was made recently by Dr. Leland Haworth, ANS president and director of the Brookhaven National Laboratory, Upton, N. Y.

It was announced also that Octave J. DuTemple has been appointed executive secretary of the ANS. Mr. DuTemple, an associate chemical engineer on Argonne National Laboratory's staff, replaces Dr. W. W. Grigorieff, who has accepted a post with the recently formed International Atomic Energy Agency of Vienna, Austria.

ANS sponsors two meetings of its own annually for specialists interested in atomic energy. Together with more than a score of other professional engineering societies, it plays a primary role in arranging the technical program for the annual Nuclear Congress.

ASME Mid-Hudson Section Holds Successful Steam Power-Plant Conference at Poughkeepsie, N. Y.

More than 300 persons attended the technical sessions and banquet of what proved to be an interesting and enjoyable affair—The American Society of Mechanical Engineers Mid-Hudson Section Steam Power-Plant Design Conference on May 8, 1958.

On the morning of May 8, a field trip through the Danskammer Point Steam Station was conducted, which 228 members and guests attended. The tour got under way at about 9:30 a.m. and lasted until noon. After luncheon, registration was conducted at the South Road Offices of Central Hudson Gas & Electric Corporation adjacent to the auditorium, where the technical sessions and banquet were to be held in Poughkeepsie.

All 350 seats were occupied for the afternoon session, at which eight technical papers were presented, covering the design of a typical modern steam station from site selection to initial operation.

Herbert Reynolds, Mem. ASME, consulting engineer, made the opening presentation, and Thomas Mullen finished the afternoon sessions with a summary of the entire design. William Byrne, Vice-President of ASME Region II, was introduced by Daniel Spina, chairman of the Mid-Hudson Section, who welcomed those attending the dinner on behalf of the sponsoring Section. Mr. Byrne carried on the proceedings by introducing Harold R. Dean, Mayor of the City of Poughkeepsie, who welcomed the group and presented the City's best wishes and hopes that they would be meeting again in Poughkeepsie.

After presenting the members at the head table, Mr. Byrne presented Edward Martin, president of Metal and Thermit Corporation, with a Fellow ASME Certificate and also presented William Legier with a certificate from ASME Council for his past-chairmanship and activities on the Executive Committee of the Mid-Hudson Section.

S. C. Hollister, Hon. Mem. ASME, the principal speaker of the evening, gave a most illuminating address titled "How to Come Down off a Peak." After the meeting, Dr. Hollister commented, "This conference is illustrative of the great interest in the many recent developments affecting the power field.

"The rapid growth that is ahead in power generation to keep up with the needs in residential as well as industrial areas brings forward many new problems in power engineering. The American Society of Mechanical Engineers furnishes a means for a continuing discussion of these new problems."

The great success of this conference points out the practical aspects of small sections organizing such a meeting in their own area. William Legier, Conference Chairman, in expressing his gratitude for the fine co-operation given by Mr. Acker, president and general manager of Central Hudson Gas & Electric Corporation, and the chairmen, whose committees exerted every effort to make the conference as successful as it was, namely, George Furlong, Registration; Herbert Kelly, Arrangements; and Donald Carhart, Announcements; stated that without the co-operation of the entire organization, including the Advisory Committee and the Technical Committee, the conference could not have had the wide reception that it enjoyed.

ASME Mid-Hudson Section conference on steam power-plant design in Poughkeepsie attended by large audience. *Left to right:* Herbert Reynolds, opening session speaker; S. C. Hollister, Hon. Mem. ASME, principal speaker of the evening; and E. G. Bailey, past-president and Hon. Mem. ASME, who also attended the meeting.

How Well Do You Know Your Society?

So that the members of ASME may know their Society, attention is called to the list of Manuals and Annuals available upon request from the ASME Order Department, 29 West 39th Street, New York 18, N. Y. Unless otherwise noted, all the items in the list will be sent without charge.

AC 2	Annual Report of ASME Research
AC 10	Personnel of Council, Boards, and Committees
AM 1	Membership List—Alphabetical and Geographical (Biennial—odd-numbered years)
AM 3	Catalog of Publications (also included in "Mechanical Catalog")
AM 4	Members List—Listed by Companies (Biennial—even-numbered years, $2 each)
AM 5	Indexes to ASME Papers and Publications (Published annually in January issue of *Transactions of ASME*)
MM 1	Certificate of Incorporation, Constitution, By-Laws, and Rules
MM 2	Know Your Society
MS 4	An ASME Paper (50 cents to nonmembers)
MS 61	Citizenship and Participation in Public Affairs

ASME COMING EVENTS

(*For Meetings of Other Societies, see page 96*)

August 18-21

ASME-AIChE Heat Transfer Conference, Edgewater Beach Hotel, Chicago, Ill.

September 8-9

ASME Applied Mechanics Western Conference, University of California, Los Angeles, Calif.

September 15-17

ASME Process Industries Conference, Statler-Hilton Hotel, Buffalo, N. Y.

September 21-24

ASME Petroleum Mechanical Engineering Conference, Cosmopolitan Hotel, Denver, Colo.

September 28-October 1

ASME Power Conference, Statler-Hilton Hotel, Boston, Mass.

October 9-10

ASME-AIME Fuels Conference, Hotel Champlain, Old Point Comfort, Va.

October 13-15

ASME-ASLE Lubrication Conference, Statler-Hilton Hotel, Los Angeles, Calif.

November 30-December 5

ASME Annual Meeting, Statler-Hilton and Sheraton-McAlpin Hotels, New York, N. Y.

March 8-11, 1959

ASME Gas Turbine Power Conference and Exhibit, Netherlands-Hilton Hotel, Cincinnati, Ohio

March 8-12, 1959

ASME Aviation Conference, Statler-Hilton Hotel, Los Angeles, Calif.

April 5-10, 1959

Nuclear Congress, Cleveland Auditorium, Cleveland, Ohio

April 13-15, 1959

ASME Hydraulics Conference, University of Michigan, Ann Arbor, Mich.

April 19-23, 1959

ASME Oil and Gas Power Conference, Shamrock-Hilton Hotel, Houston, Texas

April 23-24, 1959

ASME Management-SAM Conference, Statler-Hilton Hotel, New York, N. Y.

April 29-May 3, 1959

ASME Metals Engineering Conference, Sheraton-Ten Eyck Hotel, Albany, N. Y.

May 4-5, 1959

ASME Maintenance and Plant Engineering Conference, Edgewater Beach Hotel, Chicago, Ill.

May 12-14, 1959

ASME Production Engineering Conference, Statler-Hilton Hotel, Detroit, Mich.

May 25-28, 1959

ASME Design Engineering Conference, Convention Hall, Philadelphia, Pa.

June 14-18, 1959

ASME Semi-Annual Meeting, Chase-Park Plaza Hotel, St. Louis, Mo.

June 18-20, 1959

ASME Applied Mechanics Conference, Virginia Polytechnic Institute, Blacksburg, Va.

Note: Members wishing to prepare a paper for presentation at ASME national meetings or divisional conferences should secure a copy of Manual MS-4, "An ASME Paper," by writing to the ASME Order Department, 29 West 39th Street, New York 18, N. Y., for which there is no charge providing you state that you are a member of ASME.

Second ASME International Air Pollution Congress Planned for 1958 Is Postponed

The second International Congress on Air Pollution to be presented by The American Society of Mechanical Engineers, originally scheduled for September 4 and 5 of this year at the Statler-Hilton Hotel, New York, N. Y., has been postponed for one year, until Sept. 10–11, 1959.

The announcement was made recently by G. V. Williamson, chairman of the ASME Committee on Air Pollution Controls.

The reasons for this postponement include the following: The difficulties and delays in obtaining official approval for authors of papers from foreign countries to complete the preparation of their papers, to obtain approval of them, and to make arrangements for attending the Congress in New York City.

"We sincerely regret the need for postponement," said Mr. Williamson, "but feel that the Congress will serve its purpose as a forum for discussion of air pollution much better if it is truly representative of international thinking and research in the field of air pollution than if it is curtailed because of difficulties in obtaining adequate representation."

Mr. Williamson expressed his thanks to those who have co-operated so far in the preparations for the Congress and sought the continuance of their support and full participation. He added that plans are progressing satisfactorily for 1959 and from every indication the event should prove to be a "representative occasion" for a thorough presentation and discussion of developments and activities in air-pollution research and practice all over the world.

ASME-ASLE LUBRICATION CONFERENCE OCTOBER 13–15

The large number or research papers offered for the 1958 ASME-ASLE Lubrication Conference cover a wide range of subjects. With so many excellent papers to choose from, papers of special value and interest to all concerned with lubrication are assured. The papers cover the following general subjects: Hydrodynamics of gas-lubricated bearings, gear lubrication, lubrication of rolling contact bearings, mechanism of wear, lubrication of bearings exposed to radiation energy, high-temperature lubrication, and lubricants and their properties.

The 1958 conference is to be held at the Statler Hotel in Los Angeles, Calif., October 13, 14, and 15. It is the fifth jointly sponsored Lubrication Conference; and preliminary planning indicates it will surpass all previous conferences, both with respect to quality of the papers presented and in attendance.

The local committee is arranging trips and entertainment for the women's program and conferees are urged to bring their wives. This is an excellent opportunity to take a West Coast vacation either before or after attending the technical sessions.

Conducted for the National Junior Committee

N. J. VIEHMANN[1]

JUNIOR FORUM

The Other Half

This article is intended to demonstrate by example how the young engineer can forge a place for himself and become active in ASME affairs.

By Robert E. Jonelis[2]

WHAT does a man expect from his engineering society? Each of us has certain ideas about this, depending on the industry we are associated with, our age, our position, and so on. More than 20,000 men (about one-half of the total ASME membership) are Associate Members under the age of 35. At least one of the concerns of these young men is to find a place where they can develop in their profession. In Chicago the "Associate Committee" has provided a place where this need can be filled.

In the years immediately following World War II this Committee had its beginning as the Chicago Section Junior Committee. Coincidentally, that is the same period in which the National Junior Committee was founded. A group of progressive young engineers banded together and, with the sanction of the Section Chairman, did what they could on behalf of the young ASME members in the area. At that time the Section did not have the co-ordinated organization which it now has. Each Division would conduct a meeting where and when it desired, with little consideration for conflicting activities. Likewise the Junior Committee conducted meetings independently. These were usually devoted to a subject of interest to the younger men and were unusually successful. Attendance often run over 200.

During 1952 and 1953 the Junior Committee worked with the Section Chairmen, E. C. Bailey (1952-1953) and E. F. Obert (1953-1954), to develop a co-ordinated organization. In 1953, the Section Organization, as it is today, was put into practice.

Now the complete program for the year is mapped out during the summer. Each Professional Division is responsible for providing one technical program on a specific predetermined date. The meetings are conducted at the same location on the first Wednesday of each month. An industry sponsored "free" cocktail hour precedes the dinner and technical meeting. Normally, two or more professional divisions present programs simultaneously. All members attending dine together, enjoy a nontechnical after-dinner talk, and then adjourn to whatever technical session suits their fancy. This format has been one of the main reasons for the success the Chicago Section has enjoyed.

Under the new organization, the Chicago Section Junior Committee is responsible for conducting at least one session a year and for obtaining the after-dinner speaker each month. Since then, the committee has been striving constantly to find other ways and means of serving the young engineers in the Section.

One of the early innovations was the Junior "Prize Paper Contest." Papers are actively solicited by the Prize Paper Committee. Each year the three most worthy papers are presented orally in competition at a section meeting. This has proved to be a valuable tool for developing enthusiasm and professional pride in the many participants and, incidentally, has started many a man off on an active career with ASME.

When the Society changed the category of "Junior" to "Associate," this committee also changed its name to the "Associate Committee." Through the years the Associate Committee has built the reputation of being the spark plug of the Section. When tough or urgent tasks confront the Section, it is often said, "Give it to the Associates and the job will be done." All the active Section members, both past and present, have a great deal of pride in the Associate Committee, and considerable faith in the young men comprising its active core. Many of the present senior officers first became active through this Committee.

The committee always works under the jurisdiction of the Section Operating Board. Arbitrary and independent action could serve only to undermine the structure of the Section Organization. Its officers are selected by the committee, but appointed by the Section Chairman. Its assignments also come from the Section Chairman, and any new programs

Roster of Members

Chicago Section Associate Committee

C. M. Atterbury
W. A. Chittenden
C. Cucullu
F. R. Danker (*Vice-Chairman*, 1958-1959)
R. H. Engel
J. T. Ellis, Jr. (*Chairman*, 1958-1959)
L. Grossman
L. H. Jaxon
T. R. Kroeschell
W. A. McConchie (*Secretary*, 1958-1959)
H. R. Nelson
R. Sahlstrom
E. Selig
R. J. Wohlwend
A. Zummer
R. A. Holstedt (Adviser)
R. E. Jonelis (Adviser)

A group at the Annual Associate Party are, *clockwise*, Bill Chittenden, Tom Kroeschell, Raye Selig, Ernie Selig. Sue Kroeschell, and, *standing*, Charlie Atterbury

[1] Product Planning Engineer, Western Electric Company, North Andover, Mass. Assoc. Mem. ASME.

[2] Engineer, Commonwealth Edison Company, Chicago, Ill. Assoc. Mem. ASME; member, National Junior Committee; past-chairman, Chicago Section Associate Committee.

Roy Sahlstrom, Bob Jonelis, Charlie Atterbury, Ernie Selig, Dick Engel,
Bill Chittenden, Tony Zummer, Fred Danker, Jack Ellis

are always cleared before being embarked upon.

There are normally about 15 to 20 members on the committee. Because of the many reassignments by industry to other areas of the country, there is a rather fast turnover in membership. However, this assures that there is always room for a man who wants to become active.

Aside from what has already been outlined, the Associate Committee has become responsible for a number of other continuing projects. In order to show the type of work that a group of younger men can take on, some of these tasks are listed:

1 The committee handles publicity for the Section. Besides numerous newspaper releases on important events, a series of radio programs and two television programs have been conducted.

2 They have organized a plant representation group to act as direct liaison between the Society and various industries.

3 A wage survey of ASME members in the Section was conducted, analyzed, and distributed.

4 Inspection trips are conducted for the Section. This year a trip through Argonne National Laboratory was organized.

5 Student forums have been conducted at the three major engineering colleges in the area. The purpose of the forums is to inform the students of what they can expect to be doing when they are graduated. By choosing the field for which they are best suited and most interested, they should become better, and more successful engineers. The panels were composed of Associate Committee members, each one representing a different phase of mechanical engineering: i.e., sales, design, operating, and so on.

It is interesting to note that a fourth school in the area, a two-year preparatory college, recently has asked the Committee to conduct the forum at their campus.

The Student Forum is a type of program which was developed by the National Junior Committee. The first such session was conducted at Newark College of Engineering in 1956, under the auspices of the National Junior Committee.

Each program, of course, is calculated to benefit the young engineers of the Section. But each new task also provides a spot for another young man to become active in Society work.

By the simple expedient of receiving minutes of the National Junior Committee meetings, each member of the Associate Committee is kept informed of its national counterpart's programs and policies. Thus the committee can be guided by the National Organization and can assist in carrying out its over-all projects.

A new organization of young men is just this year being developed at the Regional level under the name of the Region VI Junior Committee. Members of the Chicago Section Associate Committee initiated the organization of this group. It is expected that the gap between the National and Sectional groups will be effectively bridged by the new Regional Junior Committee. In addition, the many young engineers away from the larger cities or Section headquarters will now have the opportunity to become active and will have a group to represent them.

When each Section and each Region ultimately develops a "Junior" committee the growth and strength of the Society and the profession will be served. When the younger half of the Society is provided with a place to become active, these men will remain with the Society, and through their combined efforts the Society will be able to assume tasks heretofore considered impossible.

CHAIRMAN'S CORNER

At the August meeting the National Junior Committee will nominate two candidates for appointment by the President of the Society for five-year terms on the Committee. The Committee would especially like to receive nominations from Sections and Regions not presently represented by its ten members. Seven Sections in only three Regions are currently represented.

Please mail your nominations to the Committee Secretary: Mr. Peter D. Hansen, 3-246, Massachusetts Institute of Technology, Cambridge 39, Mass.

The candidate should be under thirty years old and he should be able to attend and give sufficient time to Committee and Society affairs.

Norman J. Viehmann, *Chairman*
Junior Forum

ASME CODES AND STANDARDS WORKSHOP

ABC Unification Symbol For American Standards

RECOGNITION of ABC Unified Standards by means of a symbol and legend, such as pictured below, has been recommended by the ASME Standardization Committee and approved by the Board on Codes and Standards for use on the covers of American Standards published by the Society which have achieved partial or complete unification with the national standards of Britain and Canada.

The first use of the legend will probably be on the new Proposed American Standard Miniature Screw Threads, now with ASA for approval. An important use will be on the covers of the American Standard Drafting Manual.

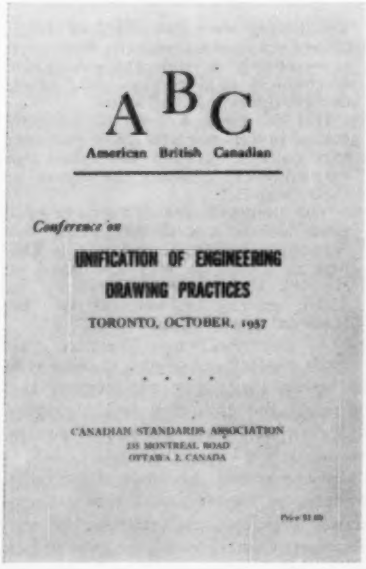
Standards which are considered unified will have the legend added when either revised or reprinted. These include the following American Standards: Surface Roughness, Waviness, and Lay (B46.1-1955); Preferred Limits and Fits for Cylindrical Parts (B4.1-1955); Square and Hexagon Head Bolts and Nuts (B18.2-1955); Microscope Objective Thread (B1.10-1958); Unified and American Screw Threads (B1.1-1949).

Report of 1957 ABC Conference Now Available

THE report of the 1957 ABC Conference on Unification of Engineering Drawing Practices has been published by the Canadian Standards Association. The 32-page booklet provides the official statement issued at the close of the Conference, a summary of the results, the attendance, and the day-to-day record of the Conference proceedings and discussions.

Included is a four-page record of the points of difference in the three national standards at the time of the Conference. Removal of still more of these differences is now being attempted. Use of these sheets should aid in understanding Canadian or British drawings. In addition, recommended symbols for geometric and positional tolerance are shown.

Copies are available at $1 each from the Canadian Standards Association, 235 Montreal Road, Ottawa 2, Canada.


A B C
American British Canadian

Conference on

UNIFICATION OF ENGINEERING DRAWING PRACTICES

TORONTO, OCTOBER, 1957

CANADIAN STANDARDS ASSOCIATION
235 MONTREAL ROAD
OTTAWA 2, CANADA

Interpretations of 1955 Code for Pressure Piping

FROM time to time certain actions of the Sectional Committee B31 will be published for the information of interested parties. While these do not constitute formal revision of the Code, they may be utilized in specifications, or otherwise, as representing the considered opinions of the Committee.

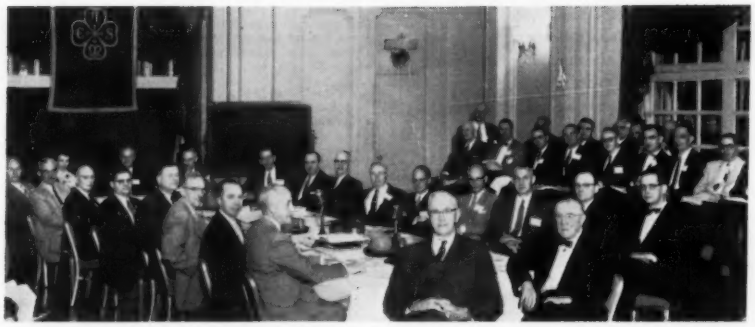
Pending revision of the Code for Pressure Piping, ASA B31.1-1955, the Sectional Committee has recommended that ASME, as sponsor, publish selected interpretations so that industry may take immediate advantage of corresponding proposed revisions. Case No. 29 is published herewith as an interim action of Sectional Committee B31 on the Code for Pressure Piping that will not constitute a part of the Code until formal action has been taken by the ASME and by the American Standards Association on a revision of the Code.

Case No. 29

Inquiry: Is Refrigeration Piping associated with process operation within the limits of a plant as defined in Par. 302 of ASA B31.1-1955, Section 3, within the Scope of Section 3 or of Section 5 of the ASA B31.1-1955, Code for Pressure Piping?

Reply: It is the opinion of the Committee that a conflict exists in the Scope paragraphs of Sections 3 and 5 on Refrigeration Piping associated with process operation. However, it is the intent of the Code that this Refrigeration

H. B. Oatley honored by ASME Boiler and Pressure Vessel Committee



ASME Boiler and Pressure Vessel Committee in session in Minneapolis, Minn., April 25

Piping associated with process operation within the limits of a plant as defined in Par. 302 of ASA B31.1-1955 is within the Scope of Section 3, "Refinery and Oil Transportation Piping Systems."

For allowable stresses and other requirements and limitations for subzero services see Case No. 30.

H. B. Oately Recipient of ASME Award

Henry Bigelow Oatley, Hon. Mem. ASME, was presented a Certificate of Award in testimony to the high regard of his co-workers and the deep appreciation of the Society for his valued services in advancing the engineering profession as a member of the Boiler and Pressure Vessel Committee. Presentation was made on April 29 by Robert A. Vitolo at a meeting of the Long Island Subsection of the ASME.

Mr. Oatley has served on the Main Committee as a member, vice-chairman, and for ten years as chairman, in addition to serving on the Executive Committee, the Subcommittee on Boilers of Locomotives, Subcommittee on Safety Valve Requirements, Subcommittee on Nonferrous Materials and many special committees. He was recently presented a certificate of Honorary Membership to the Boiler and Pressure Vessel Committee by H. E. Aldrich, chairman of the Committee.

During his 57 years as a member of the Society, Mr. Oatley has also been a member of the ASME Committee on Power Test Codes and has aided ASTM committees in development of specifications for steel tubes, pipe, and plates. From 1943 to 1956 he was chairman of ASTM Committee A1 on steel and on retirement from that office was appointed by ASTM as an honorary member. His other affiliations include the Society of Naval Architects and Marine Engineers, The Engineering Institute of Canada, The Institute of Naval Engineers and the Northwest Coast Institution of Engineers and Shipbuilders.

Certificates of Award

In appreciation of their outstanding leadership in the development of standards and codes sponsored by the Society, the Council has presented Certificates of Award to Prof. Milton C. Stuart, recently retired head of the Department of Mechanical Engineering of Lehigh University, and William L. H. Doyle, who has retired as assistant director of research of the Caterpillar Tractor Company. Both of these engineers have given faithful service to the Society and the profession in their work on Power Test Codes Committees.

From September, 1926, to April, 1956, Professor Stuart served as a member of PTC Committee No. 1 on General Instructions. He was a member and chairman of PTC Committee No. 11 on Fans from March, 1933, to April, 1956. In October, 1929, he was appointed to PTC Committee No. 10 on Centrifugal and Turbo-Compressors and Blowers and served until the committee was discharged in April, 1950. Professor Stuart was a member of the standing Power Test Codes Committee from April, 1936, until his resignation in December, 1957.

Mr. Doyle also was a member of the standing Power Test Codes Committee from February, 1943, until his resignation in December, 1957. He will, however, continue his assignments on a number of the technical committees. He became a member of PTC Committee No. 20 on Speed, Temperature, and Pressure Responsive Governors in February, 1940. Since July, 1956, he has been a member of the newly organized PTC Committee No. 26 on Speed Governing Systems for Internal-Combustion Engine-Generator Units. In November, 1939, he was appointed a member of PTC Committee No. 17 on Internal-Combustion Engines and has served as secretary since November, 1945. Since June, 1949, he has been a member and chairman of the Joint AIEE-ASME Subcommittee on Recommended Specifications for Speed Governing of Internal-Combustion Engine-Generator Units.

ASME Boiler and Pressure Vessel Committee Out-of-Town Meeting

The 1958 Out-of-Town Meeting of the ASME Boiler and Pressure Vessel Committee was held jointly with the annual meeting of the National Board of Boiler and Pressure Vessel Inspectors from April 22 to April 25, inclusive, at the Radisson Hotel, Minneapolis, Minn.

The purpose of these meetings is to give opportunity for Code users located in the meeting area to become better acquainted with the personnel of the Committee and its methods of operation, as well as to present practical Code problems.

It was the intent of the Committee this year to conduct the Subcommittee and Main Committee meetings in much the same way as is done when the meetings are held in New York City.

The meeting was one of the best attended in several years with about 300 present. It indicated growing interest in the field of boilers and pressure vessels.

J. S. Clarke Appointed to Boiler and Pressure Vessel Committee

The appointment of James S. Clarke as a member of the Boiler and Pressure Vessel Code, Main Committee, was announced on April 4, 1958, by James W. Landis, ASME President.

Mr. Clarke is with the Esso Research and Engineering Company and engaged in the development and design of refinery equipment in both process and mechanical fields. From 1942 to 1946

J. S. Clarke appointed to ASME Boiler and Pressure Vessel Committee

he served in the Army and was assigned to the Petroleum Administration for War in charge of operation of government-owned alkylating plants making avgas high-octane blending agent.

He holds four U. S. Patents and is the author of many technical papers on erosion and maintenance of catalytic cracking units. Presently he is serving on the Subcommittee on Unfired Pressure Vessels and the Subcommittee on Special Design.

ENGINEERING SOCIETIES PERSONNEL SERVICE, INC
[Agency]

THESE items are from information furnished by the Engineering Societies Personnel Service, Inc., in co-operation with the national societies of Civil, Electrical, Mechanical, and Mining and Metallurgical Engineers. This Service is available to all engineers, members or nonmembers, and is operated on a nonprofit basis.

In applying for positions advertised by the Service, the applicant agrees, if actually placed in a position through the Service as a result of an advertisement, to pay a placement fee in accordance with the rates as listed by the Service. These rates have been established in order to maintain an efficient nonprofit personnel service and are available upon request. This also applies to registrant members whose availability notices appear in these columns. Apply by letter, addressed to the key number indicated, and mail to the New York office.

When making application for a position include six cents in stamps for forwarding application to the employer and for returning when necessary. A weekly bulletin of engineering positions open is available at a subscription of $3.50 per quarter or $12 per annum for members, $4.50 per quarter for nonmembers, payable in advance.

NEW YORK	CHICAGO	DETROIT	SAN FRANCISCO
8 West 40 St.	84 East Randolph St.	100 Farnsworth Ave.	57 Post St.

Men Available[1]

Mechanical Engineer, MS, BSME, New York University, 1955; 24; desires position in sales or production and manufacturing leading to management; supervisory, administrative, and technical experience attained since graduation as assistant maintenance and operational projects officer in U. S. Navy squadron. Available early in November. Prefers West, Southwest, or Overseas. Me-597.

Design Engineer, ME; 52; machine design, paper machinery: driers, calenders, reelers, winders, cutters, two years; plastics-processing equipment, seven years; shoe machinery: cutters, nailers, gluers, sewing machines, conveyers, 10 years; four years' supervisory experience. Prefers East. Me-598.

Engineer, PE; 59; past nine years as industrial consultant with U. S. and United Nations Technical Assistance programs in Europe, Middle and Far East. Prefers Europe, Middle or Far East, Africa. Me-599.

Administrative or Consulting Engineer, 62; 40 years' experience design, operation, sales, maintenance, naval, marine, power, process machinery. Held "top secret" and "Q" clearances. Health perfect. Have administered large organizations and contracts. Location immaterial; willing to travel. Me-600.

Executive Sales Engineer or Manager, 39; more than 17 years' experience in supervisory engineering and sales on complete nuclear, chemical, and industrial plants. Particular emphasis on fabricated-process equipment. Desires association with firm where progressively modern ideas on sales promotion, advertising, and positive selling will be given fair trial. Will negotiate compensation after first year's positive results. Location immaterial. Me-601.

Design or Development Engineer, BSME, PhB; 26; two years with Du Pont in maintenance studies and power utilization; desires position designing or developing mechanisms, automatic machinery. Any place, but South preferred. Me-602-887-Chicago.

Engineer or Quality Control, BME, licensed PE in N. Y.; 32; eight years with U. S. Army Signal Supply Agency, Quality Assurance Division. Familiar with government contracts for electronic equipment, MIL requirements and statistical sampling, and QC techniques. Prefers Conn., N. Y., northern N. J. Me-603.

Chief Engineer, BS and MSME; 37; two years teaching mechanics and thermodynamics; ten years in design and development for rotating machinery, pressure vessels, and chemical equipment; three years as supervisor. Several courses in metallurgy. Prefers East. Me-604.

Administrative or Liaison Engineer, BS(ME) and MME, PE N. Y. State; 33; four-and-one-half years turbine-steam design engineer (thermodynamics); two years active Naval duty (ordnance and design officer); five years engineering education (thermodynamics and power). Prefers East, Midwest, or West. Me-605-9752-Detroit.

Vice-President Engineering, MS(ME); 46; 20 years' administrative and engineering experience in job-lot durable goods products ranging from precision hydraulic items and automatic machines to large tanks and pressure vessels, including development and design, engineering standards, patents, budgets. Location immaterial. Me-606.

[1] All men listed hold some form of ASME membership.

Positions Available

Sales Engineers. (*a*) Graduate engineer, about five years' experience in air-conditioning field with special emphasis on large engineered air-conditioning systems; considerable experience with high-pressure induction systems required. Will contact consulting engineers to obtain specification and approval of heating, ventilating, and air-conditioning equipment. Must be top flight air-conditioning engineer and salesman. $10,000, plus sales expenses. (*b*) Sales engineer, graduate, business administration degree desirable, to contact owners, architects, general contractors, banks, etc., to promote sale of heating, ventilating, and air-conditioning equipment. Must be completely familiar with air-conditioning systems as they affect building design, construction, and cost. Must be able to prepare accurate estimates of owning and operating costs, etc. Must be top flight salesman. $10,000, plus sales expenses. N. Y. area. W-6140.

Teaching Personnel. (*a*) Instructors, BS(ME), to teach engineering drawing and descriptive geometry. Opportunity to take postgraduate courses. (*b*) Assistant professor to teach above subjects. Should have master's degree in engineering and some experience in teaching. Positions available September, 1958. South. W-6147.

Vice-President, Sales, 40–55, preferably an engineering degree, for manufacturer of blowers, vacuum pumps, and meters. Will direct all sales activities, including field sales, market research, sales planning and forecasting, application engineering, and service. Should presently be a general sales manager or at least an assistant sales manager, with product background in blowers, steam turbines, superchargers, reciprocating machines, or any fluid-moving equipment of the capital-goods-type. $20,000–$24,000, plus bonus. Midwest. W-6159.

Vice-President for Sales, Europe; 35–50, degree in metallurgical or mechanical engineering preferred, substantial sales and sales-management experience in Europe in the distribution of a basic commodity. Will plan and execute all aspects of a program designed to increase the sale of basic metals to European customers. Will take charge of offices in New York City and England together with four agents in various countries. Must be fluent in French; knowledge of German desirable. Headquarters, New York City. W-6167.

Sales Engineer, 35–45, experience in storage and instantaneous heaters, hot-water converters, and oil preheaters to take clients' specifications and select the design and estimate heaters required. Salary open. New England. W-6173.

Plant Engineer, graduate mechanical or chemical, two to five years' experience in operating, repair, and maintenance of mechanical equipment. Prefer applicant with mechanical-equipment background. Job duties will include analysis of the mechanical phase of operating and maintenance problems. Must be U. S. citizen. Pa. W-6175.

District Sales Representative for manufacturer of heavy construction and mining equipment. Must be experienced in application of excavating and loading equipment. Sales experience desirable. Headquarters, New York, N. Y. W-6179.

General Manager, 35–45, graduate mechanical, experienced in converting machinery for paper and pulp industry. Must know paper bag and cutting paper. Will be responsible for sales, production, and finance. $12,000, plus bonus. Conn. W-6182.

Instructor for a position that combines placement of students and instruction in personnel and labor relations. Placement work will include direction of honor students in a co-operative summer program; also will include participation in normal recruitment of students by industry. Instruction will be in the personnel-relations and industrial-relations fields. Level of applicant will be determined by applicant's educational background and teaching experience; industrial experience also considered. Work during summer. Available September, 1958, or possibly July 1, 1958. N. Y. area. W-6187.

Sales Engineer, several years' experience in maintenance department of a large steel mill or an electric-power company to handle sale of products which include replacement coils for winding motors and generators, and rewinding and repair of rotating apparatus and electrical insulating materials. General Electric or Westinghouse test course desirable. Territory, northeastern Ohio. W-6188.

Associate Professor, mechanical engineering, PhD preferred, interest in development of research program. About $700 per month. Available September, 1958. Northern New England. W-6193.

Engineer, 30–40, electrical or mechanical graduate, for large insurance organization. Utility-power-plant experience particularly desirable, also some knowledge of nuclear engineering. Background should make applicant adaptable for activities in other engineering fields, leading to position of general engineering consultant. Must be U. S. citizen, and have, or be able to obtain Secret clearance. Salary open; placement fee to be negotiated. Some traveling. New York, N. Y. W-6195.

Sales Executive, about 36–48, graduate mechanical or chemical engineer, experienced in organizing and managing national sales of heavy mechanical equipment to chemical, petrochemical, and process industries, and to utilities. Company is preparing to market a new line of equipment and will develop a separate sales organization. Salary open but substantial. East. W-6201.

Industrial or Management Engineer, graduate industrial or mechanical, five or more years' experience in plant layout, methods development and improvement, material-flow procedures, and incentive systems, preferably allied to manufacturing, packaging, and warehousing operations of the food, chemical, or pharmaceutical industries. To start, $10,000. Upstate N. Y. W-6208.

Assistant Director of Engineering, graduate, to 50; considerable experience in material-handling equipment field; knowledge of electrical and structural as related to material-handling equipment. Will assist director of engineering to supervise 18 engineers in standardization program. Must be good administrator. Good potential. $12,000, plus bonus; good fringe benefits. Employer pays fee. N. Y. State. W-6216.

Senior Project Engineers. (*a*) Senior project engineer, production, graduate mechanical, to 55, minimum of 12 years' progressive engineering and manufacturing experience, preferably on precision devices. Experienced in both mass production and job-shop manufacturing practices. Will review existing designs to determine practicability of function in accordance with customer requirements and specifications; to analyze existing product designs for feasibility of manufacture and to develop economical manufacturing methods, etc. $9000–$12,500; good fringe benefits. (*b*) Senior project engineer, development, master's degree in mechanical engineering, 30–45, minimum of seven years' responsible mechanical and electromechanical product-design experience. Will do creative design and development of new precision mechanical and electromechanical products for industrial and government applications. $9000–$11,500. Must be U. S. Citizens. New York metropolitan area. W-6223.

Engineers. (*a*) Plant engineer, to 35, for multiplant building-materials manufacturer; some experience in gypsum, cement, lime, or similar process industries. Chance for advancement into management. (*b*) Production superintendent for gypsum-board plant, to 35, graduate engineer; supervisory experience in a gypsum-wallboard plant desired, for a multiplant building-materials manufacturer. Western U. S. W-6224.

Engineers for machine design and development group. (*a*) Senior product engineer, graduate mechanical, five to 15 years' experience in designing products in the office-machine field with special emphasis in operating mechanisms such as paper-handling systems, drive mechanics, sheet metal, and die-cast construction; must be capable of carrying out major responsibility of product design. (*b*) Production engineer, graduate mechanical, ten to 15 years' experience, familiar with design in the manufacture of electromechanical machines and equipment. (*c*) Mechanical engineers, two to five years' experience in development work on electromechanical equipment. Upstate N. Y. W-6226.

Engineers for an engineering-service division. (*b*) Fluid mechanics, to 35, BS in chemistry or mechanical engineering with elective undergraduate courses in physics, mathematics, applied mechanics, fluid mechanics, thermodynamics, or unit operations; minimum five years of industrial, teaching, research, development, or design experience with fluid hammer, cavitation, acoustical shock, etc. (*c*) Applied mechanics, to 35, BS in civil or mechanical engineering with elective courses in advanced strength of materials, machine design, and vibration. Minimum of five years in machine design and machine development or teaching involving the study and testing of structures, machines, and pressure vessels. Company pays all placement fees; relocation expenses, etc. East. W-6227.

Engineers for an engineering-service division. (*a*) Corrective maintenance engineer, 30–35, graduate mechanical, civil, or metallurgical, seven to ten years' experience at plants or in central engineering specializing in mechanical-equipment problems or mechanical improvement. (*c*) Water engineer, 30–35, graduate chemical or mechanical engineering, with at least eight years of industrial water-treatment experience involving boiler feedwater, cooling water, ion exchange, boiler inspection, etc. Company pays all placement fees; relocation expenses. East. W-6228.

Research and Development Engineers for pulp and paper laboratory. (*a*) One required for mechanical development and design of equipment. (*b*) One required for fluid mechanics' problems in papermaking. (*c*) One required for research on stock preparation, mechanical treatment in pulp and fibers. (*d*) Six required for research on general problems of papermaking. Salaries open. East Central. W-6235.

Time-Study Supervisor, for diversified metal-

Keep Your ASME Records Up to Date

The ASME Secretary's Office depends on a master membership file to maintain contact with individual members. This file is referred to countless times every day as a source of information important to the Society and to the members involved. All other Society records are kept up to date by incorporating in them changes made in the master file.

The master file also indicates the Professional Divisions in which members have expressed an interest. Many Divisions issue newsletters, notices of conferences or meetings, and other material. You may express an interest in the Divisions (no more than three) from which you wish to receive any such information which might be published.

Your membership card includes key letters, below the designation of your grade of membership and year of election, which indicate the Divisions in which you have expressed an interest. Consult the form on this page for the Divisions to which these letters pertain. If you should wish to change the Divisions you have previously indicated, please so notify the Secretary.

It is highly important to you and to the Society to be certain that our master file indicates your current mailing address, business or professional-affiliation address, and interests in up to three Professional Divisions.

Please complete the form, being sure to check whether you wish mail sent to your residence or office address, and mail it to ASME, 29 West 39th Street, New York 18, New York.

Please Print

ASME Master-File Information

Date

LAST NAME | FIRST NAME | MIDDLE NAME

POSITION TITLE | NATURE OF WORK DONE
e.g., Design Engineer, Supt. of Construction, Manager in Charge of Sales, etc.

NAME OF EMPLOYER (Give name in full) | Division, if any

*☐

EMPLOYER'S ADDRESS | City | Zone | State

ACTIVITY, PRODUCT, or SERVICE OF EMPLOYER; e.g. Turbine Mfrs., Management Consultants, Oil Refinery Contractors, Mfr's. Representative, etc.

*☐

HOME ADDRESS | City | Zone | State

☐

PRIOR HOME ADDRESS | City | Zone | State

* CHECK "FOR MAIL" ADDRESS

Address changes effective when received prior to:

I subscribe to

☐ MECHANICAL ENGINEERING	10th of preceding month
☐ Transactions of the ASME	20th of preceding month
☐ *Journal of Applied Mechanics*	20th of preceding month
☐ *Applied Mechanics Reviews*	1st of preceding month

Professional Divisions in which I am interested (no more than *three*) are marked X.

☐ A—Aviation	☐ J—Metals Engineering	☐ S—Power
☐ B—Applied Mechanics	☐ K—Heat Transfer	☐ T—Textile
☐ C—Management	☐ L—Process Industries	☐ U—Maintenance and Plant Engineering
☐ D—Materials Handling	☐ M—Production Engineering	☐ V—Gas Turbine Power
☐ E—Oil and Gas Power	☐ N—Machine Design	☐ W—Wood Industries
☐ F—Fuels	☐ O—Lubrication	☐ Y—Rubber and Plastics
☐ G—Safety	☐ P—Petroleum	☐ Z—Instruments and Regulators
☐ H—Hydraulics	☐ Q—Nuclear Engineering	
	☐ R—Railroad	

working shop, supervising 20 time-study engineers and clerical staff. Should have solid industrial-engineering experience and education, preferably in medium-heavy industry. Must be capable of administering time standards in existing wage-incentive system and be familiar with development of standard data from time studies. $8000–$10,000. Upstate N. Y. W-6236.

Design and Development Engineer, mechanical graduate, with at least five years' design experience in medical equipment, appliance, or allied fields. $8000–$10,000. Western N. Y. State. W-6240.

Engineers. (*c*) Mechanical engineer with design experience or potential, for machine-design work. (*d*) Chemical or mechanical engineer with several years' experience in plastics, polymers, or extrusion for process-engineering work. Apply by letter, giving complete details including salary requirements. Va. W-6242.

Lubrication Engineer, mechanical or chemical-engineering graduate, industrial-equipment experience in production or maintenance engineering for application and sales promotion of industrial lubricants. $6000–$6500. Territory: Bronx, Westchester County, N. Y., and lower Conn. W-6244.

Development Engineers. (*a*) Development engineer A, graduate mechanical, aircraft engine and accessories experience for company manufacturing engine valves and regulators. Should have several years' board-design experience. Considerable customer contact. $7500–$9500. (*b*) Development engineer B, graduate mechanical, aircraft-engine experiences; two years' minimum drafting, to operate test panels and other acceptance tests. $6000–$8000. Northern N. J. W-6247.

Engineers. (*a*) Project engineer, ME degree preferred but almost any degree in engineering coupled with sound engineering experience is suitable. A minimum of eight years' engineering experience desired, including some project-engineering background. Experience in rocket propulsion would be valuable, as well as experience in development testing, thermodynamics, stress, kinematics, system analysis, or machine design. (*b*) Assistant project engineer, same general qualifications as above, but in a lesser degree, for work involving development of new rocket engines. (*c*) Project chemist to assist in the co-ordination of propellant research projects. Principal functions are technical liaison, customer contact, and project management. (*d*) Technical writer, engineering education, or a technical background desirable, for a publications group. Experience in writing, editing, or publication of technical reports essential. Md. W-6248.

Sales Engineers, three, mechanical-engineering degree or equivalent, with sales experience, preferably on boiler or auxiliary equipment sold to, and used in, power plants. Work will deal with the sale of boilers, steam generators, and combustion equipment to large industrial companies and public utilities. Must have own car; will be compensated on a mileage basis. Base salary and expenses plus commission. Territories: two for metropolitan areas and one for southern territory. Headquarters, New England. W-6249.

Chief Designer, Machinery and Equipment, mechanical graduate, to 40, five to 15 years' design and supervisory experience on machinery manufacture and mechanical equipment (presses, power transmissions, drives, electric or hydraulic controls, hydraulic cycles, valves, pumps) for manufacturer. Knowledge of shop, engineering department, and general practices; able to run department and handle design, supervise customer, shop, and engineering-department problems. $9000–$12,000. Sacramento Valley, Calif. S-3469.

Designer, Truck Trailers, mechanical graduate or equivalent, under 50; will consider well-experienced or recent graduate with aptitude and interest in this work. Will be concerned with design of truck bodies, trailers, or components (familiar with stress and structural analyses in chassis and body, structural shear, and moment diagrams, and knowledge of test methods, and familiar with electronic strain-gage work). Must be able to do board work and set up tests. U. S. citizen; experience in aircraft structures or railroad-car designs may be acceptable. $525–$575 per month for limited experience, or commensurate with more experience. San Francisco East Bay. S-3545.

Estimator, Materials Handling (Crane), mechanical graduate, to 50, well qualified to estimate, bid purposes, for manufacturer of medium-sized materials-handling equipment, principally crane-type. Will work with draft proposals, compose specifications; comprehend size and application of mechanical equipment and materials; estimate mechanical drives; manufacturing and engineering labor; estimate mechanical drives cost and material cost; develop and originate cost reference; determine ac/dc hoist and tractive drive motor and brake sizes; deal with fabricated steel sections, stress analysis; analyze labor and material cost from estimated weight; select ac/dc motor brakes, controls; electric applications, specifications, and service; acquainted with crane-type electric circuitry. About $12,000. San Francisco Peninsula. S-3546.

Teachers for mechanical-engineering department; prefer MS or PhD, but will consider BS if experience qualifies for: (*a*) Aeronautical engineering, to take charge of courses in aero option and assist in heat power; (b) mechanical engineering, to take charge of courses in machine design, kinematics, vibrations, etc. Salary and rank depend on qualifications. Available in September, 1958. Rocky Mountain area. S-3587.

ACTIONS ASME EXECUTIVE COMMITTEE

A MEETING of the Executive Committee of the Council of The American Society of Mechanical Engineers was held in the rooms of the Society on May 2, 1958. In the absence of the Chairman, J. N. Landis, President of the Society, C. E. Crede, Vice-President, Region I, presided. Also present were: E. W. Allardt, L. N. Rowley, and G. B. Warren of the Executive Committee; E. G. Bailey, D. W. R. Morgan, and W. F. Ryan, past-presidents; Joseph Pope and V. Weaver Smith, directors; E. J. Kates, treasurer; Dudley F. Phelps, chairman, Membership Review Committee; T. A. Marshall, Jr., senior assistant secretary; D. C. A. Bosworth, S. A. Tucker, and J. D. Wilding, assistant secretaries; and Ernest Hartford, consultant.

Death of P. W. Swain. The Committee noted with sincere regret the death on April 27, 1958, of Philip W. Swain, retired editor of *Power* magazine, and ASME Lecturer for four years.

Transactions ASME. The Committee voted to modify action taken April 4, 1958, establishing subscription rates for the four *Journals* which will constitute Transactions ASME as of Jan. 1, 1959, to provide the rates as recommended by the Publications Committee and the Board on Technology. (See pages 128 and 129 of June, 1958, issue of MECHANICAL ENGINEERING for further details.—Editor.)

Prices of Technical Papers. On recommendation of the Publications Committee and the Board on Technology, the Executive Committee voted to set the following scale of prices for individual copies of ASME technical papers ("preprints"), effective with the 1958 Annual Meeting:

1 40 cents per paper to members.
2 80 cents per paper to nonmembers except to nonmember registrants at meetings where papers may be purchased at the member rate.
3 Books of 10 coupons: $3 to members, $6 to nonmembers.
4 A book of 10 free coupons will continue to be provided annually to each member, and 5 free coupons will continue to be provided annually to each Student Member.

ASME-AIChE Joint Conference. Approval was voted of holding an ASME-AIChE Joint Heat Transfer Conference, Aug. 9–12, 1959, at the University of Connecticut, Storrs, Conn.

Research Agreement. The Secretary was authorized to execute supplemental Agreement No. 1 to the Research, Agreement between ASME and Oklahoma State University for research on the pressure-deflection characteristics of Bourdon tubes, effective Feb. 1, 1958, through June 1, 1958, at no increase in the financial liability of the Society.

Baton Rouge Subsection. Change in the status of the Baton Rouge Group to the Baton Rouge Subsection of the New Orleans Section was approved.

Gantt Medal Board of Award. Approval was voted of an advance from "A" Development Fund to the Gantt Medal Board of Award for republication of the writings of Henry Laurence Gantt, to be repaid from royalties accrued to the Board.

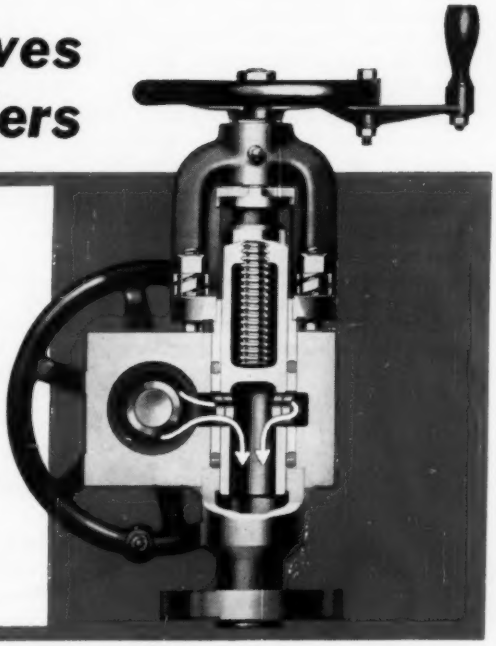
Towne Lecture. It was noted that L. R. Boulware was unable to accept the invitation to deliver the Towne Lecture at the 1958 Semi-Annual Meeting. Because of lack of time to appoint a replacement, a Towne Lecturer for that meeting will probably not be named.

1958 Power Show Advisory Committee. ASME representatives on the 1958 Advisory Committee for the Power Show were named as follows: J. N. Landis, President, ASME; H. C. R. Carlson, E. W. Jacobson, R. B. Smith, and G. B. Warren, ASME directors on the Board on Technology; T. F. Perkinson, chairman, ASME Board on Technology; G. R. Fryling, chairman, ASME Meetings Com-

(*ASME News continued on page 114*)

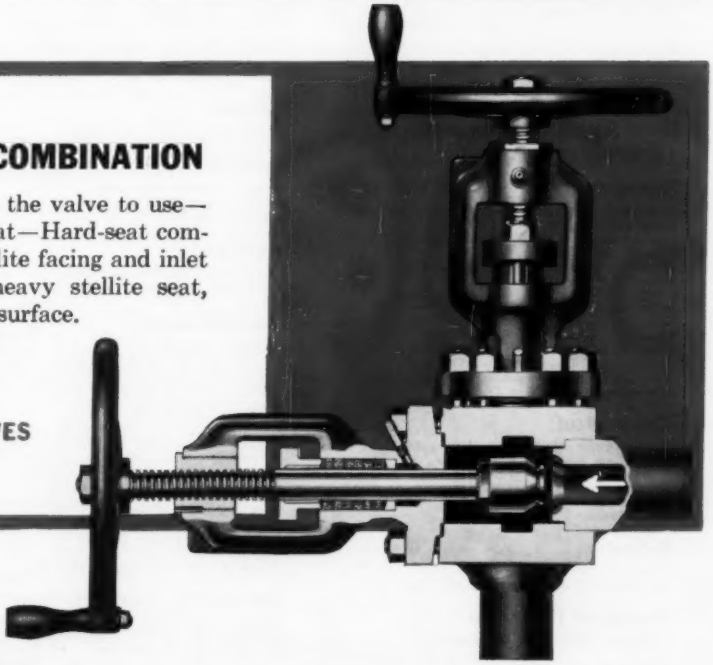
UNIT TANDEM

rugged blow-off valves for high pressure boilers



HARD-SEAT—SEATLESS COMBINATION

■ For boilers up to 1500 psi, this Yarway Unit Tandem Blow-Off Valve offers the maximum in dependable service. A one-piece forged steel block serves as the common body for the Yarway Stellite Hard-seat blowing valve and the Yarway Seatless sealing valve. All interconnecting flanges, bolts and gaskets are eliminated. The Unit Tandem at right is sectioned through Seatless Valve to show balanced sliding plunger in open position and free flow.



HARD-SEAT—HARD-SEAT COMBINATION

■ For boilers to 2500 psi, this is the valve to use—Yarway's Unit Tandem Hard-seat—Hard-seat combination. Disc has welded-in stellite facing and inlet nozzle has integral welded-in heavy stellite seat, providing smooth, hard-wearing surface.

OVER 4 OUT OF 5
HIGH PRESSURE PLANTS
USE YARWAY BLOW-OFF VALVES

Write for Yarway Catalog B-434

YARNALL-WARING COMPANY
108 Mermaid Ave., Philadelphia 18, Pa.
BRANCH OFFICES IN PRINCIPAL CITIES

YARWAY **BLOW-OFF VALVES**

mittee; and O. B. Schier, II, secretary, ASME.

Certificates of Award. Certificates of Award were granted to the following retiring section chairmen: William V. Bishop, Atlanta; Edward L. Vieth, Cincinnati; John E. Gerding, Cleveland; Lawton L. Johnston, CSRA, 1957–1958; James E. Ettorre, Fairfield County; R. Keith Tobin, Westmoreland; I. H. Lundgren, Youngstown; and Harry E. Lundberg, Fairfield County, July 1, 1957 to Dec. 31, 1957.

Engineers Joint Council. Articles of Incorporation for Engineers Joint Council, issued by the Secretary of the State of New York, March 20, 1958, and certain amendments and changes to the Constitution of EJC, among which was a revision to include the American Institute of Industrial Engineers as a constituent society, were approved. It was reported that the EJC Board of Directors has accepted the Louisiana Engineering Society as an affiliate member. On recommendation of the EJC Board of Directors the ASME Executive Committee voted to accept the application of the American Institute of Plant Engineers for associate membership in EJC.

National Transportation Policy. The Executive Committee voted to recommend that Engineers Joint Council undertake a major study looking toward the development of a national transportation policy, covering air, water, highway, rail, etc.

AIChE 50th Anniversary. Preparation of an appropriate scroll to AIChE in commemoration of its fiftieth anniversary was approved.

Recognition of Engineers. It was voted to recommend to Engineers Joint Council that its Committee on Honors undertake a survey of the various statues, plaques, and other media recognizing the achievements of engineers in communities throughout the country and develop a plan for permanent recognition of engineers at the local level.

Appointments. The following appointments were noted:

Stephen D. Moxley, inauguration of President Frank A. Rose, University of Alabama, April 9, 1958.

Ralph L. Goetzenberger, inauguration of Dr. MacDonald, Rector, Catholic University of America, April 16, 1958.

William H. Byrne, dedication of Rogers Hall and inauguration of President Ernst Weber, The Polytechnic Institute of Brooklyn, April 19, 1958.

A. W. Weber, T. H. Chilton, and D. L. Katz, Fiftieth Anniversary of the American Institute of Chemical Engineers, Philadelphia, Pa., June 22–27, 1958.

E. P. Berg, ASME representative, Washington Award Dinner, Chicago, Ill., May 9, 1958.

CANDIDATES FOR MEMBERSHIP AND TRANSFER IN ASME

THE application of each of the candidates listed below is to be voted on after July 25, 1958, provided no objection thereto is made before that date and provided satisfactory replies have been received from the required number of references. Any member who has either comments or objections should write to the Secretary of The American Society of Mechanical Engineers immediately.

New Applications and •Transfers

California

CARLSEN, WILLIAM F., San Carlos
FIEDLER, RICHARD P., Hollywood
GOLESTAN, BOLAND, So. Pasadena
•GROSS, WILLIAM A., San Jose
HOWELL, ROBERT P., San Francisco
KEIFF, SIDNEY, Rivera
LUCHETTI, HENRY R., Mountain View
MARBLE, ROBERT I., Gardena
MEDOW, JULES, Los Angeles
•PARDEN, ROBERT J., Santa Clara
•STANNARD, JAMES H., JR., San Francisco
STEVENS, WILLIAM M., San Francisco
TREADWELL, WALTER L., Alameda
WOLPERT, ARLEN, San Diego

Connecticut

•BROADHEAD, MORGAN A., Naugatuck
•BUCKLEY, EDWARD P., Granby
•CORNELL, ROBERT W., West Hartford
DICKEY, THOMAS A., Fairfield
MCCLURE, ALAN C., Groton
ZACK, DAVID F., Deep River

Delaware

DUVEKOT, THEODORE, Wilmington
MCKENNA, THOMAS A., Wilmington

District of Columbia

JOHNSON, PHILIP V., Washington

Florida

REED, CHARLES R., Pensacola

Georgia

•HOVAN, STEPHEN B., Chamblee

• Transfer to Member or Affiliate.

Illinois

•BACKLUND, JOHN R., Bloomington
JOHNSON, RICHARD L., Rock Island
MEZERA, ERVIN F., Evergreen Park
NUGENT, WILLIAM W., Kenilworth
SCHAFER, JOHN H., Chicago
SCHROYER, GEORGE B., Chicago

Indiana

SAGER, HOMER A., Mishawaka

Kentucky

DEAN, LOUIS A., Paducah
KEMP, CHARLES E., Benton
RICHESON, HENRY A., Paducah

Maryland

•ANI, MAURICE, Severna Park
•REUWER, MILTON J., Army Chemical Center

Massachusetts

ENGLISH, ROBERT E., Norwood
FINLAYSON, FRANK S., Worcester
FORRESTER, RICHARD L., Watertown
HAMM, CHARLES R., Marblehead
HOYER, DONALD C., Springfield
MCKAY, RICHARD F., Boston
ROSS, DONALD M., Townsend
STASZESKY, FRANCIS M., Boston
WARD, HARRY C., Milton

Michigan

BIEL, FRANK A., Detroit
CAREY, JAMES F., Birmingham
KANAAN, ZIVAD M., Detroit
O'CONNELL, EDWIN J., Detroit
PAPWORTH, ROBERT L., Houghton

Minnesota

FINGERSON, LEROY M., St. Paul
•RUDOLPH, JAMES E., Minneapolis
•WEDEL, ERWIN, St. Paul

Missouri

CLEMENS, WILLIAM J., Kansas City
LEINWEBER, DONALD M., Lee's Summit

Nebraska

•WILKINS, JACK L., Omaha

New Jersey

BLATTNER, ERNEST W., Trenton
BURGERT, HENRY, JR., Bergenfield
MUIR, ARTHUR J., Englewood
MULLEN, JOSEPH F., Teaneck
•PARASKEVAS, PAUL T., Roselle Park
SNYDER, BAIRD, Maplewood
VALVA, VINCENT T., Harrison

New Mexico

LEMMON, GEORGE V., Albuquerque
SIMMONS, CHARLES L., JR., Albuquerque
WILKES, PERRY R., JR., Albuquerque

New York

CAMMACK, WILLIAM C., JR., Jamaica, L. I.
CARNEY, FRANCIS X., Binghamton
•CHASE, ROBERT S., JR., New York
CLEARY, JOHN V., JR., Mt. Vernon
•FERGUSON, GROVER W., Beacon
•FISCHER, GEORGE K., Bay Shore, L. I.
GARRISON, MAURICE R., Buffalo
HERBST, JOHN G., Jamaica, L. I.
•KAUFFMANN, WILLIAM M., Hamburg
KOGA, YOSHIO, New York
•LANDIS, FRED, New York
LANGE, ESWORTHY P., New York
LEVIS, WILLIS S., JR., Rhinebeck
MURRAY, PATRICK J., Flushing
PALMITER, LAVERN W., Wellsville
PUMMER, ROWLAND A., New York
SCHUTTLER, FRED J., South Ozone Park
SLATER, ROBERT W., New York
SZOMANSKI, EUGENIUSZ, Bay Shore, L. I.
•TILLINGHAST, JOHN A., Valhalla
WESTFALL, GEORGE C., Scotia
WHITNEY, GILBERT C., JR., Dansville

North Carolina

BEECHING, SIDNEY R., High Point
O'BRIEN, DUDLEY, Charlotte
WHITEHEAD, HENRY L., JR., Charlotte

Ohio

ANDADURAI, GOBI D., Cleveland
BRISCHER, GEORGE M., Shaker Heights
CHAUDHURY, SUBHENDUJYUTI B., Cleveland
CHIAVERINI, MAURO, Circleville
FURNISS, LOREE E., Columbus
GRENGA, JOSEPH R., Youngstown
GUIMONT, FOREST R., Alliance
HAUG, CHESTER J., Cleveland

(ASME News continued on page 116)

Headquarters for the Conference and Exhibits will be Chicago's famous Edgewater Beach Hotel. Air conditioning, comfortable rooms, accomodations for Conference activities, and facilities for after-hours relaxation.

INTERESTED IN HEAT TRANSFER?
. . . this will suit you to a ΔT!

2nd National Heat Transfer Conference and Exhibit
Edgewater Beach Hotel, Chicago, August 18-20, 1958

FOR EVERYONE concerned with the broad field of heat transfer, the 1958 Conference and Exhibit promises to be one of the top events of the year. The first Conference, held last year at Penn State, enjoyed tremendous success. From indications of the interest and enthusiasm now building up, this year's event should prove to be an even bigger success.

The theme of the 2nd National Heat Transfer Conference and Exhibit will be industrial and practical applications of heat transfer, plus some theoretical aspects. Two technical sessions, mornings and afternoons. Once again, the Conference will be co-sponsored by the American Institute of Chemical Engineers and The American Society of Mechanical Engineers.

The Program Chairmen—A. S. Foust, Professor of Chemical Engineering, Lehigh University, for AIChE and Sigmund Kopp, Chief Application Engineer, Alco Products, for ASME—More than fifty papers—will be pre-printed and distributed as part of the registration fee.

A high-spot of this year's event will be the exhibits of leading manufacturers in the heat transfer field, featuring latest in equipment, materials and techniques. A partial list of companies which have scheduled exhibits includes: American Heat Reclaiming, Baker Perkins, Cardox, Curtiss-Wright, Dow Chemical, Kontro, Monsanto, MSA Research, National Carbon, Parks-Cramer, Republic Steel, Royal McBee, Thermon, Whitlock.

You can look forward to meeting with a distinguished group of fellow-engineers from all types of industrial & engineering firms, universities, research organizations, etc.—all with special interests in one or many phases of heat transfer.

A complete advance program, housing information, a social schedule, and full registration details are now ready. Accomodations will be limited, so please don't wait to make *your* arrangements. Use this convenient coupon or write on your company letterhead.

Sponsored by the American Institute of Chemical Engineers and The American Society of Mechanical Engineers

Mr. Joel Henry, Assistant Secretary
American Institute of Chemical Engineers
25 W. 45th Street, New York 36, N.Y.

Please send me a program and registration details for the 2nd National Heat Transfer Conference and Exhibit.

Name.....

Street.....

City, Zone & State.....

Company.....

Position.....

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●KOMISAR, AARON, Cincinnati
MEIKLEJOHN, JAMES, Barberton
MURTY, TENNETI S., Cleveland
RAVINDRAN, NEELAKANTAN, Cleveland
SAIT, ALFRED J., Cincinnati
●SCHRANK, EDWIN P., Akron
SETTY, K. A. V., Cleveland
SRINIVASA, SAMPATHIENGAR, Cleveland
●VARGO, E. JAMES, Cleveland

Oklahoma

PETERSON, MELVIN J., Tulsa
TOWNER, JOHN W., Tulsa

Oregon

LEISURE, EVERETT R., Portland

Pennsylvania

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●ASCHENBRAND, WILLIAM H., JR., North Wales
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HAMMOND, CHARLES P., Baden
●HERTER, THOMAS J., Pittsburgh
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MARSHALL, TERRELL, JR., Rutledge
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●NEYER, ROBERT D., Oreland
OBLEY, ALAN L., Irwin
●REBER, JOHN, JR., Manheim
REID, RUSSELL S., Pittsburgh
REINITZ, FREDERICK, Philadelphia
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Tennessee

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●ABRAMSON, HYMAN N., San Antonio
ADAMS, CHARLES N., Odessa
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MARSH, GARELD E., Houston
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●TANG, SUI S., Houston

Vermont

MCGINLEY, JEREMIAH E., Essex Junction

Virginia

●CUNNINGHAM, JOHNNIE M., Roanoke
FRUCHTMAN, IRVING, Hampton
MORSE, FREDERICK T., Charlottesville

Washington

●HOUSER, RICHARD W., Seattle
●LANDERHOLM, RALPH E., Spokane
THAYER, JOHN A., Seattle

Foreign

BOUCHER, RAYMOND, Montreal, Que., Canada
COLLINSON, NORMAN R., Toronto, Ont., Canada
CROSSLEY, JOHN H., Intercol, Barranca, Colombia
ELIDOROS, THEODORE, Montreal, Que., Canada
GREAVES, LESLIE C. H., Wolverhampton, England
HARDWICK, BARRIE J., Toronto, Ont., Canada
JAIN, SANT S., Calcutta, West Bengal, India
●LINARES, CARLOS T., Lima, Perú
SADLER, ROBERT C., Toronto, Ont., Canada
●SANCHEZ, ALVARO, Bogotá, Colombia
TAYAL, HARI P., Renfrew, Scotland

OBITUARIES

Peter G. Chun (1925–1957), tool design engineer, Levy & O'Keefe, New York, N. Y., died Nov. 24, 1957. Born, Melbourne, Australia, Dec. 26, 1925. Parents, K. C. and Ivy Chun. Education, BS(AE), Cornell University, 1950. Married, Ida-Tung Chun, 1955. Assoc. Mem. ASME, 1950. Survived by his widow.

Charles Remington Ellicott (1880–1957), retired vice-president, Westinghouse Air Brake Co., New York, N. Y., died November, 1957. Born, Chicago, Ill., Nov. 13, 1880. Parents, Joseph Remington and Jessie (Ford) Ellicott. Education, BS, Yale University, 1902. Married Marion Follett, 1903; children, Charles R., Jr.; Mary Elizabeth; and Joseph Andrew. Mem. ASME, 1916. Mr. Ellicott began his career with Westinghouse Air Brake in 1902 as an apprentice and in subsequent years was construction engineer, representative, Eastern manager, and resident vice-president. Survived by his widow.

Samuel David Fitzsimmons (1889–1957), consulting engineer, Pawtucket, R. I., died May 11, 1957. Born, Taunton, Mass., Sept. 30, 1889. Education, attended high-school. Mem. ASME, 1924. Early in his career Mr. Fitzsimmons had been employed by the Jencks Spinning Co. Subsequently he was employed by the State of Rhode Island, the Y.M.C.A., and the Brown & Sharpe Manufacturing Co.

Edward Vinton French (1868–1958?), whose death recently was made known to the Society, was the retired president of Arkwright Mutual Fire Insurance Co., Boston, Mass. Born, Lynn, Mass., March 11, 1868. Parents, Benjamin V. and Elisa Ellen (Tufts) French. Education, BS, Massachusetts Institute of Technology, 1889. Married Mary O. Wentworth; two daughters, Helen Wentworth (Mrs. Jerome C. Greene) and Mrs. Margaret Vinton Brown. Mem. ASME, 1905. For over 40 years Mr. French had been actively engaged in fire-protection engineering problems. Before joining the fire insurance company of which he later became president, he had for a short period been an instructor in the mechanical-engineering department at M.I.T. During World War I he served with the AEF as a Major in the U. S. Army. He was the author of a book, "Factory Mutual Insurance," and of several articles on fire protection.

Vivian Joseph Gianelloni (1892–1957), executive vice-president and director, Punta Alegre Sugar Sales Co., Havana, Cuba, died November, 1957. Born, Longwood Plantation, La., Oct. 28, 1892. Parents, Sabin Joseph and Julie Marie (Lefebvre) Gianelloni. Education, BS, Audubon Sugar School, Louisiana State University, 1913. Married Marcelle Ellis Tarilton, 1918 (d. 1939), four sons, Vivian, Jr., Giles S., Arthur L., and Ignatius L. Gianelloni. Married 2nd, Marjorie Daniell, 1940. Jun. ASME, 1917; Assoc.Mem. ASME, 1919; Mem. ASME, 1924. Mr. Gianelloni had been an expert in the design, erection, and operation of cane sugar factories. He served in World War I as a lieutenant in the U. S. Army, Coast Artillery Corps in France. He was a member of Sociedad Cubana de Ingenieros, Asociasión de Técnicos Azucareros, and American Chamber of Commerce.

Joseph Haag, Jr. (1896–1958), president, Todd Shipyards Corp., New York, N. Y., died March 10, 1958. Born, New York, N. Y., Sept. 14, 1896. Parents, Joseph and Nellie (Grandon) Haag. Education, Stevens Institute of Technology, 1918; hon. ME, 1944. Married Camilla Marie Ashurst, 1935. Mem. ASME, 1931. Mr. Haag had been with Todd Shipyards since 1917. He served as an engineering officer in the U. S. Navy during World War I. Early in Wold War II he negotiated with the British Purchasing Commission in the construction of shipyards in Maine and California where 60 British freighters were built and the blueprints laid for the U. S. wartime shipbuilding programs. For these efforts he received the Navy's Certificate of Commendation. He was a member of the American Bureau of Shipping and a director of the Shipbuilders Council of America. Survived by his widow; and two sisters, Miss Florence G. Haag and Mrs. Edna Busschaert.

Albert J. Horton (1876–1958), patent attorney, R. Hoe and Co., Inc., New York, N. Y., died March 6, 1958. Born, New York, N. Y. Dec. 11, 1876. Parents, Jacob C. and Susan Adelia (McCord) Horton. Education, graduate of New York City schools. Married Emily S. Runyon, 1911; one son, Roger R. Horton. A licensed engineer in the State of New York, Mr. Horton held over 100 patents for electric motor-control equipment, printing machinery, and accessory devices. Survived by his widow, Emily R. Horton.

Marcello Aberdeen King (1892–1958), vice-president, engineering, Elliott Co., Jeanette, Pa., died March 20, 1958. Born, Wellsville, N. Y., Dec. 1, 1892. Parents, Aberdeen R. and Sarah L. (Olmstead) King. Education, BS(ME), University of Michigan, 1916. Married Eleanor M. Church, 1925. (d. 1944). Jun. ASME, 1919; Assoc-Mem. ASME, 1921; Mem. ASME, 1935; Fellow ASME, 1950. Mr. King had been with the Elliott Co. for 34 years with the exception of five years spent as executive engineer at the Worthington Pump and Machinery Corp., Wellsville, N. Y. His outstanding contributions were made toward the development of commercial lines of turbines in ranges of pressure, temperature, and capacity which had not previously been encountered except in special machines. He was also a pioneer in the development of turbine and gear drive for pumps used in hydraulic dredging. He had been the author of several papers on these subjects. Survived by his daughter, Nancy King, Greensburg, Pa.; a sister, Mrs. Clemency King Coulson, Genesee, Pa.; a niece, Mrs. Harriet Newell, Tucson, Ariz.; and a nephew, Lindsey Lord, Portland, Me.

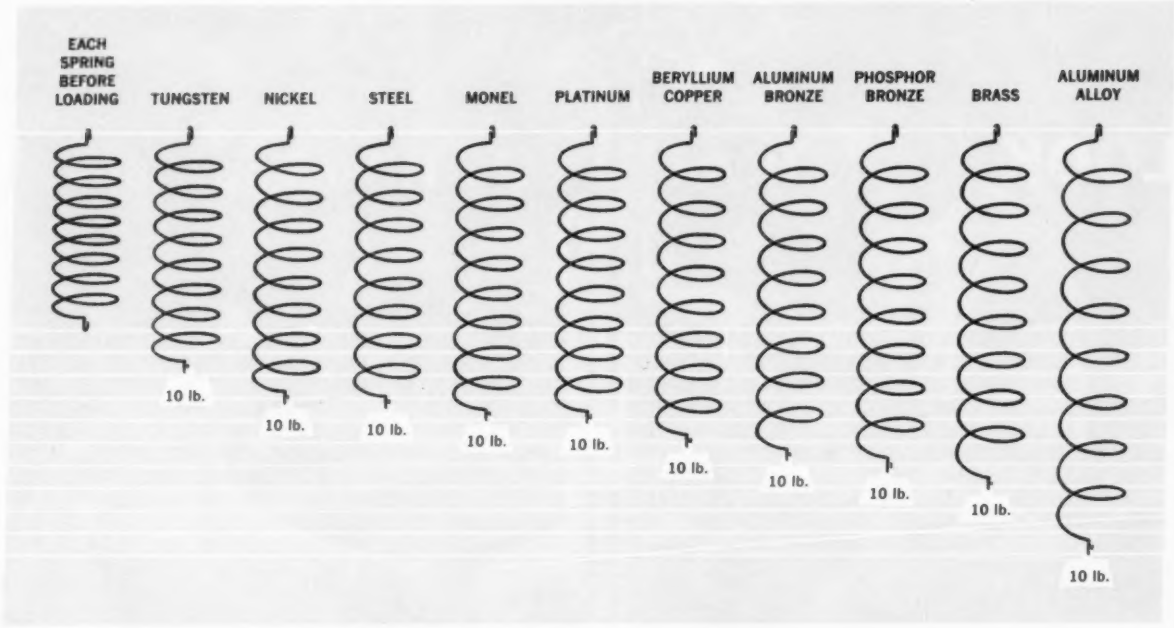
Beryl Edward Livingston (1908–1958), senior project engineer, Industrial Machinery Division, Carrier Corp., Syracuse, N. Y., died March 13, 1958. Born, Indiana, Pa., Nov. 16, 1908. Parents, Charles F. and Flora M. Livingston. Education, General Electric Co., apprentice drafting and design, 1930. Married Helen Millis, 1936. Mem. ASME, 1957. Prior to his association with the Carrier Corp., Mr. Livingston had been with the Elliott Co., Jeannette, Pa. Survived by his widow.

Marten Martensson (1892–1958), senior marine engineer, Bureau of Ships, Department of the Navy, Washington, D. C., died March 29, 1958, in Stockholm, Sweden. Born, Arboga, Sweden, Nov. 15, 1892. Parents, Marten and Ida Kristina (Flygt) Martensson. Education, ME, Chalmers Tekniska Institute, Sweden, 1914. Married Gertrud Wahren; one daughter, Louise. Assoc-Mem. ASME, 1924; Mem. ASME, 1935. Mr. Martensson served as an engineer in the Royal Swedish Navy. He was a specialist in the design and layout of steam power stations. He was a member also of the Chalmers Engineer Society, Sweden, and the American Society of Swedish Engineers.

Alfred Edwin McGruer (1900–1958), electrical engineer, Canadian Pacific Railway Co., Montreal, Que., Canada, died March 1, 1958. Born, Barrow, Lancs., England, Dec. 13, 1900. Education, Montreal Technical Institute, 1916. Mem. ASME, 1952. Mr. McGruer held a patent for an automotive direction indicator and a boiler-gage illuminator. He was the author of several papers dealing with air pollution. He held membership in the Canadian Standards Association, the International Electrotechnical Commission, the Association of American Railroads, and the Air Pollution and Smoke Prevention Association of America. He was an honorary life member of the Institute of Power Engineers, Canada. He was licensed by the Ontario government.

Kenneth W. Reed (1889–1958), consulting engineer and owner of firm specializing in machine design and development, and production management, Cleveland, Ohio, died March, 1958. Born, Beaver, Pa., Oct. 17, 1889. Parents, James M. and Amelia (Moorhead) Reed. Education, AB, Washington and Jefferson College, 1910; studied civil engineering at the University of Pittsburgh, 1911; BS(ME), Massachusetts Institute of Technology, 1913. Married Ada M. Best, 1916. Mem. ASME, 1927. Mr. Reed held patents on boxmaking and threading machinery. He had been the head of his own consulting firm since 1929. During World War II he was in charge of equipment design, layout, purchase, and installation of the Ravenna Ordnance Plant, and a plant in charge of manufacture of the VT fuse. He served the Society on the local level as chairman of membership, 1933–1934; employment, 1934; and member on research committees, 1934–1935. He was a member also of AAAS, ASM, SPEE, and the Cleveland Engineering Society. Survived by his widow; two daughters, Mrs. Dorothy V. Coates and Mrs. Margaret Clough; son, Kenneth B. Reed; six grandchildren; brother, John; and sister, Mildred.

James Joseph Ryan (1927–1958), development engineer, Struthers Wells Corp., Warren, Pa., died March 28, 1958. Born, Covington, Ky., Oct. 28, 1927. Education, BS(ME), University of Kentucky, 1951. Married Corinne Culbertson. Assoc. Mem. ASME, 1951. Mr. Ryan was president of the Warren Industrial Management Association. Prior to joining Struthers, he had been associated with E. I. du Pont de Nemours and Pennsylvania Furnace and Iron Co. Survived by his widow; two daughters, his parents, two sisters, and a brother.



How much deflection do you want in a spring?

The wide range of stiffness characteristics available in different materials offer unusual opportunity to solve spring deflection problems. How wide is shown in the chart above. The tension springs are all of identical dimensions but of different materials and indicate the relative deflection obtained from applying the same load (assuming the stresses are within safe limits). This basic principle is often overlooked in the approach to spring selection not only of extension springs but other types: flat, torsion, etc. Because our daily work includes such a wide range of spring usage, we are in a position to help you in the early stages of spring consideration, both in material selection and production short cuts. A handy pamphlet to have at your elbow is our "Metal Selector." Write for your copy.

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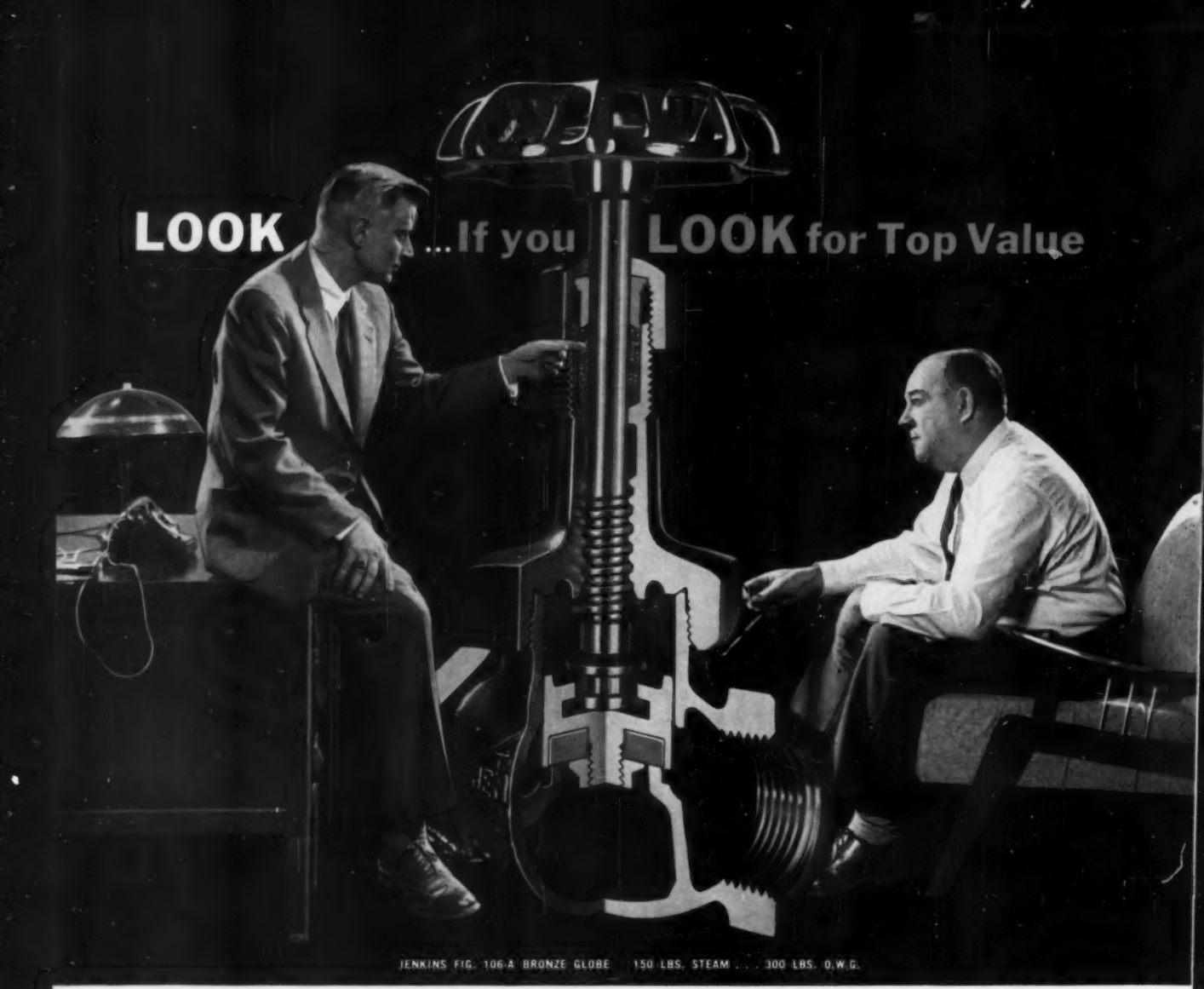
Cleveland Sales Office, Cleveland, Ohio
Dunbar Brothers Division, Bristol, Conn.
Wallace Barnes Steel Division, Bristol, Conn.
Canadian Subsidiary: The Wallace Barnes Co., Ltd., Hamilton, Ontario and Montreal, Quebec

5806



JENKINS FIG. 106-A BRONZE GLOBE 150 LBS. STEAM . . . 300 LBS. O.W.G.

in Disc Equipped Bronze Valves

LOOK at that Wheel — Tough malleable iron. Design unequalled for cool, sure grip.

LOOK at the Index Plate — Has Fig. No. etched in green background. Held by wheel nut which is secured by rolled-over spindle end.

LOOK at that Spindle — Made of high tensile bronze. See how much heavier it is . . . how many more deeply cut threads engage bonnet. And, the crowned head that reduces friction on disc holder. Sure, it costs more to make a spindle this way. But it reduces wear, preserves packing, means easier operation.

LOOK at the Packing Nut and Gland—Note the heavy and deep bronze hex. And, that bronze gland designed to compress packing toward spindle.

LOOK at that Packing Box — Its depth equals 1½ times spindle diameter. More packing space means less repacking. An asbestos, lubricated and graphited packing is used.

LOOK at that Bonnet — One-piece, screw-over design with big hex surfaces is easy to remove. Take an extra look at the bevel joint between bonnet and body, serving as an internal brace against the crushing effect of the bonnet assembly. Millions of Fig. 106-A in use for years prove this unique design licks distortion and springing.

LOOK at the Disc Holder — It's the Slip-on Stay-on type originated by Jenkins. Correct protective depth prevents flaking or cracking of disc.

LOOK at the Disc — Easily renewed without removing valve from line. Made of compositions to suit various services . . . and **made by Jenkins,** the only maker of both valves and discs.

LOOK at that Body — Just compare wall thickness of this high tensile bronze body with any other valve. The factor of safety is many times higher than rating requires. See the curved diaphragm to protect seat from distortion by pipe strain. Note that the raised seat is higher to permit more reseating operations . . . and wider, so it won't cut into disc. Pipe threads are full length and clean cut.

LOOK at this . . . for Throttling

—Just replace the standard disc nut with this Throttling Nut and a Fig. 106-A becomes well-suited to throttling service. This unique nut reduces the effects of wire drawing and its long legs restrict flow for accurate control. Many plants take advantage of this versatile valve to reduce valve and parts inventory.

THE FIRST renewable composition disc valve was a Jenkins Valve, originated nearly a century ago. Compare today's Fig. 106-A Bronze Globe with any other. See why so many valve users agree that a *Jenkins* is still the FIRST for top value. For descriptive folder No. 189-B on the full line of Jenkins Bronze Globe, Angle and Check Valves write to Jenkins Bros., 100 Park Avenue, New York 17.

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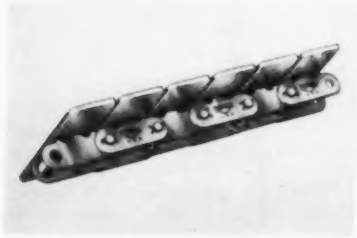
Available literature or information may be secured by using convenient Reader Service Card on page 129

NEW EQUIPMENT



Conveyor Chain

Diamond Chain Co. Inc., announces Dura-Weld conveyor chain, a new development in the manufacture of conveyor roller chain in which the top plate is welded to the chain link plates by projection welding.

This process forms a permanent metal fusion as strong as the metal itself and far superior to spot or other metal welding processes, the firm claims.

The new design is said to give up to 35 per cent more rail load bearing area than other conveyor roller chains of the same general type. It allows the use of wider supporting rails so the load can be distributed over a greater area.

The chain is detachable at any point as each link is a connecting link. It is interchangeable with present roller chains of the same general type and will operate over existing rails. **—K-1**

Double Suction Pumps

Expansion of its line of single-stage, double suction pumps for fire or booster service has been announced by Allis-Chalmers.

New additions to the line are 6 by 5-in. units (Type KSIF) rated 1000 gpm at pressures from 60 to 100 lb, an 8 by 8-in. pump rated 2000 gpm at pressures from 60 to 100 lb, and a 10 by 8-in. unit, Type SHF, rated 2500 gpm, 100 lb pressure, 1760 rpm.

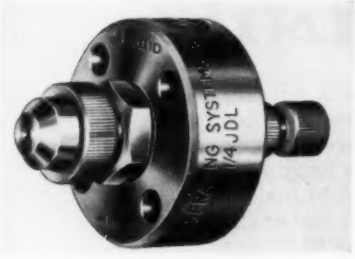
The complete line of enclosed impeller pumps is approved by Underwriters' Laboratories and Associated Factory Mutual Cos., the company reports. Units are available in capacities of 2500 gpm, at heads to 335 ft and pressures to 145 psi with inside or outside hose headers, with or without circulating relief valve, manual or automatic. **—K-2**

Oil Heater

Cleaver-Brooks Co., announces an oil heater designed for high temperature, low pressure heating of asphalt, heavy oils and concrete.

Forced circulation at 8 ft per sec is designed to distribute evenly the heat through coils. Automatic operation keeps operation safe, and air and fuel are proportioned for high combustion efficiency, the firm reports.

The Peak-Temp oil heater heats and circulates heat transfer oils through a closed system. A brochure points out how applications of hot oil heating for the pre-stressed concrete industry show lower costs and all season operation. The heater heats and circulates heat transfer oils to 450 F. The unit is produced in oil, gas, and combination oil/gas fired models: 1,800,000 Btu per hr and 3,000,000 Btu per hr input. **—K-3**



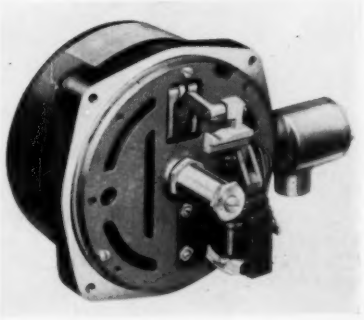
Pneumatic Atomizing Nozzles

Spraying Systems Co., announces newly designed wall-mounting pneumatic atomizing nozzles, where the body acts as the flange.

To mount the nozzle all that is required is the drilling of one hole for entry of the nozzle cap and the drilling and tapping of four 1/4 in. holes for fastening screws. When used for spraying into a pressurized chamber, a gasket between the nozzle body and wall seals the closure.

Because of this design, the nozzle is suitable for any wall thickness and may be transferred and reused with later installations no matter what the new wall thicknesses may be, the company reports.

The nozzles are available in all the firm's 1/4 J air and fluid nozzle set-ups, in a choice of brass or Type 303 stainless steel, with rear shut-off needle as shown, with clean-out needle assembly, or with plug only. They are identified as the 1/4 JDL wall mounting pneumatic atomizing nozzles. **—K-4**



Electric Brake

Stearns Electric Corp., announces the availability of an Underwriter's approved Style UH76A-9 brake with a maximum torque rating of 105 lb ft, suitable for mounting on the NEMA C flange of motor frames 213 through 256U.

By use of an adapter, mounting on 284U and 286U motor frames is possible, the company reports.

This unit is an addition to the Class I Group D line and can be offered for floor or motor mounting, horizontal or vertical mounting, alternating current only. The firm's unitizing construction, whereby all operating parts are mounted on a common plate, is also incorporated in this model. **—K-5**

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BUSINESS NOTES
NEW EQUIPMENT
LATEST CATALOGS

Diamond Abrasives

Man-made diamond abrasive wheels and hones are being added to the regular diamond abrasive line of Carborundum Co., Bonded Abrasives Div.

Designated MD, the resin-bond wheels are available in 100 and finer grits and in 25, 50, 75, and 100 concentration. Metal and vitrified bond wheels are made in selected concentrations in the same range of grit sizes. **—K–6**

Welded Metal Bellows

Welded metal bellows assemblies, custom-engineered in a variety of sizes and special metals to provide extreme accuracy and life over a wide range of critical operating conditions, are now in production at the Bridgeport Thermostat Div., Robertshaw-Fulton Controls Co.

The bellows permits designs that are 25 to 50 per cent smaller than conventional bellows, thus reducing the size of the assembly package, the company reports. The assemblies are available in small or large production runs in metals such as AISI 300 and 400 series stainless steel, inconel-X, Ni-Span-C, titanium, zirconium, and other weldable, nonferrous materials.

They may be designed with flat, spherical, stepped, and other specially-shaped plates as thin as .003 in. with ±.0001 tolerance.

The firm states that the bellows built of individually-welded plates may have many more convolutions per inch of length than conventional hydraulically-formed bellows. This, coupled with the precision inert gas welding process and the resistant characteristics of special metals used, is designed to result in a precision-controlled effective area and a lower spring rate.

The new welded bellows assemblies can be designed to meet specifications such as resistance to corrosion, fatigue, salt spray, steam, and other environments, high pressures, and extreme high and low temperatures. **—K–7**

KEEP INFORMED

BUSINESS NOTES
NEW EQUIPMENT
LATEST CATALOGS

Bleeder Valve

An original design bleeder valve made of corrosion-resistant polyvinyl chloride has been developed by Walworth Co.

The valve can be used for bleeding, sampling, or drawing off small amounts of liquid from pipe lines, duct systems, tanks, and similar applications, the company states. It has no packing and operates in the same way as a drain cock on an automobile radiator or steam boiler.

A seal formed by the back seat at the base of the valve stem is designed to insure tight closure. Left hand threading causes the valve to close when hand-wheel is rotated in the standard, clockwise direction. It has been tested successfully at pressures up to ten times recommended working pressures for pvc systems, the company reports.

The valve is available in $^3/_4$-in. size with male IPS threads. It can be screwed into any female threaded $^3/_4$-in-fitting or fixture, or can be used with appropriate bushings for size adjustments. —K-8

High Speed Lubricant

To meet the high speed and high temperature lubrication requirements of supersonic aircraft and missiles and sea and land equipment, Shell Oil Co. has developed a new "extreme temperature grease" with an operating range from −45 to 600 F.

Until now, extended lubrication intervals with conventional grease at 600 F and speeds of 30,000 rpm was impossible, the company states.

Designated grades ETR Grease B and ETR Grease D, the lubricant for the past two years was field tested by leading bearing, aircraft, and engine manufacturers, and is regarded as meeting most of the present requirements for extreme high temperature lubrication of anti-friction bearings.

In one evaluation test of high temperature performance, in a test rig operating at 10,000 rpm, the grease performed satisfactorily for 1181 hr at 450 F, 621 hr at 500 F and 162 hr at 600 F. At 450 F the bearing performance of the grease will surpass the 500 hr minimum specified in MIL-G-25013, the firm reports. —K-9

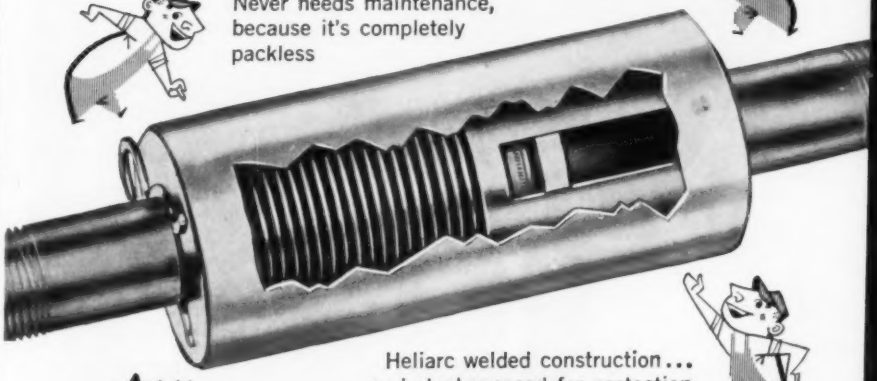
Costs Less... No Maintenance!

Flexon®

HIGH-PRESSURE, HEAVY-DUTY EXPANSION COMPENSATOR

Inch for inch, the lowest-cost way to take care of pipe motion

Never needs maintenance, because it's completely packless



Heliarc welded construction... and steel-encased for protection from external damage

Its 2-ply stainless steel Flexon bellows is designed to outlast the building

INSTALL IT... FORGET IT!

You can bank on it . . . Flexon Model H Expansion Compensators cost much less per inch of stroke than *any other method* of absorbing pipe expansion! Yet the Model H is built for hard service, with its 2-ply stainless steel Flexon bellows, positive internal guide and anti-torque device, and full protection from external damage.

This is why engineers and piping contractors are specifying the Model H for thousands of industrial piping jobs—in heating systems, process piping, steam tracing, power piping—that use pipe up to 3" and require up to 2" total movement at each Expansion Compensator. Working pressures to 175 p.s.i. for ¾" and 1" sizes; to 125 p.s.i. for larger sizes up to 3".

Make the Flexon Model H Expansion Compensator a cost-cutting part of your next piping job. Write for design and cost data, and the name of your Flexon representative.

EC-120

Flexonics corporation

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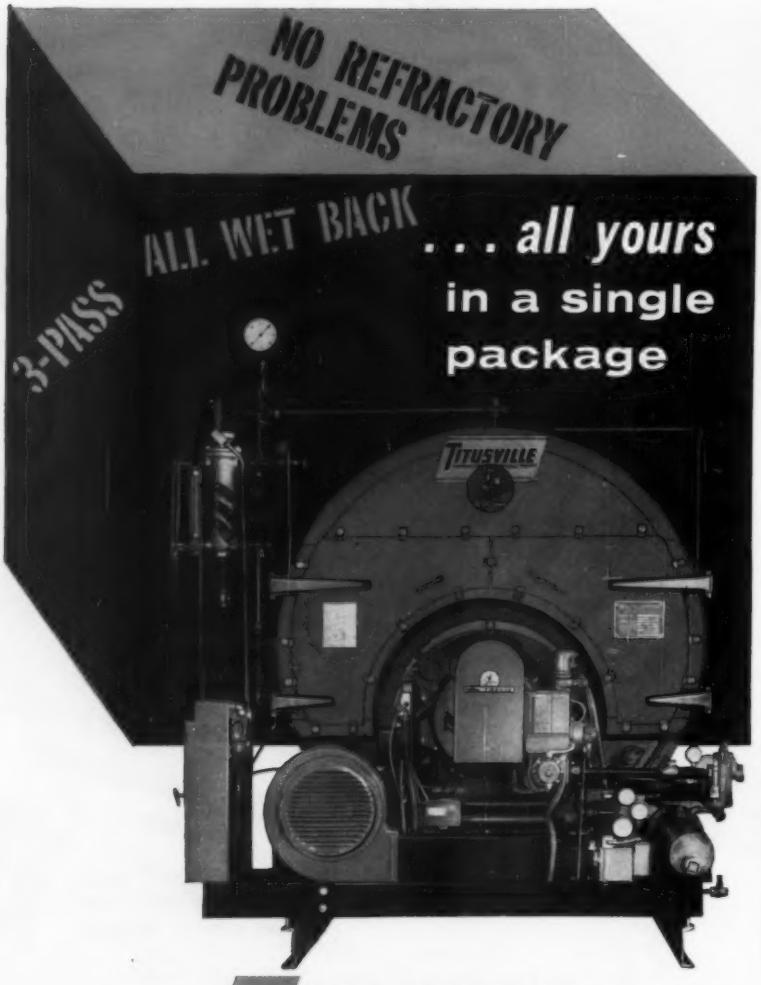

THE TITUSVILLE 3-PASS

BOILER-BURNER UNIT

This is the modern 3-PASS boiler with *complete* wet back that makes refractory problems a thing of the past . . . the Titusville Boiler that gives you faster steaming, better heat extraction, higher efficiencies all along the line! No welded tubes, lower stack temperature—everything for longer life and dependable service. *Check us!*

Write for latest Bulletin B-3333

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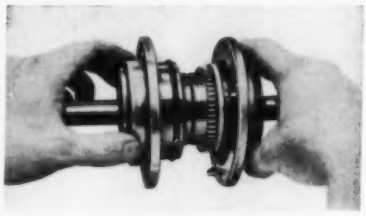

Flexible Coupling

Link-Belt Co. has announced a new low cost geared flexible coupling for shaft diameters up to $1^{7}/_{8}$ in. Called the Type MC, it is designed especially for use as a motor coupling in transmitting electric motor power to pumps, generators, speed reducers.

Basic principles of operation are like those of a conventional geared coupling, i.e., externally geared hubs are mounted on the shafts and joined flexibly by an internally geared sleeve. Power transmitting parts are steel and fully machined.

The coupling sleeve is of one-piece design, and the coupling is enclosed in a two-piece metal cover, which is sealed to prevent loss of lubricant or entry of contaminants.

The company says a special feature of the coupling centers on the use of spiral camlocking fasteners which join the cover flanges. These fasteners are permanently assembled as part of the cover halves (there are no loose bolts and nuts) and require only a quarter turn for fastening or detaching.

—K-10

Chiller-Recirculator

An improved type of liquid chiller is announced by the J. E. Watkins Co. It is said to deliver a heat transfer rate as much as double the rate obtained by immersion or dry expansion type chillers.

The upper horizontal drum of the chiller contains a conventional bank of tubes through which flows the material to be cooled. Liquid refrigerant is sprayed over the tube bank and absorbs its heat of evaporation from the tubes. Refrigerant vapor is drawn out of the top of the upper drum.

Excess liquid is drained from the upper horizontal drum to a lower drum. When the liquid rises in the lower drum to its upper control level, the drum automatically switches from the draining cycle to the pumping or return cycle. By means of high pressure gas from the receiver (or from the condenser), the excess liquid is pumped back to the chiller sprays. When the liquid falls to the lower control level, the drum automatically switches from the pumping cycle back to the draining cycle.

For freon systems, the operation is essentially the same except that a special type of oil separator is included which returns the separated oil to the crankcase of the compressor, the company reports. —K-11

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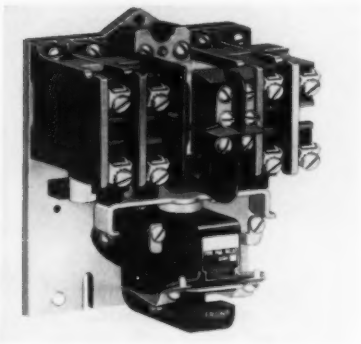


Latch Relays

Mechanically-held latched-in relays without vertical height disadvantage have been added to its line of 10-amp control relays by Clark Controller Co. The new Type PML relays are available in nine models with from two to ten poles.

Mounting dimensions are standard and parts interchangeable between Type PM magnetic relays and the new Type PML latch relays. Because the latch unit does not require increased vertical height, magnetic, and latch relays may be grouped in rows as desired without waste of panel space, the firm reports.

The latch unit occupies the space of two poles. Since the latch unit coil is designed for continuous duty, it is not necessary to use a relay pole to cut out and protect the tripping coil.

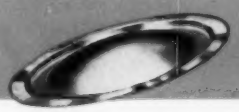
The modular construction of the PM relays is also used for the PML latch relays. Poles and latch units are individually removable and replaceable without disturbing other poles or their wiring. All access for wiring, inspection of contacts, and removal or replacement of poles or latch unit, is from the front.

Because of solid side walls provided by the modular construction, no extra electrical clearance is required between adjacent relays, conserving horizontal panel space. The construction provides a solid shelf along the relay top for flat or bundled wiring, saving an inch or more of vertical height between rows of relays, the company states. A 7/8-in. clearance is required below the relay magnet for coil change on either relay type.

Latch relays with up to six poles are available without double-decking. Contacts may be converted between normally-open and normally-closed in the field without extra parts. Latch unit wearing surfaces are nylon on phenolic. Contact carriers are nylon, and the linkage between contact carrier and magnet is floating so no vibration or shock is transmitted. —K-12

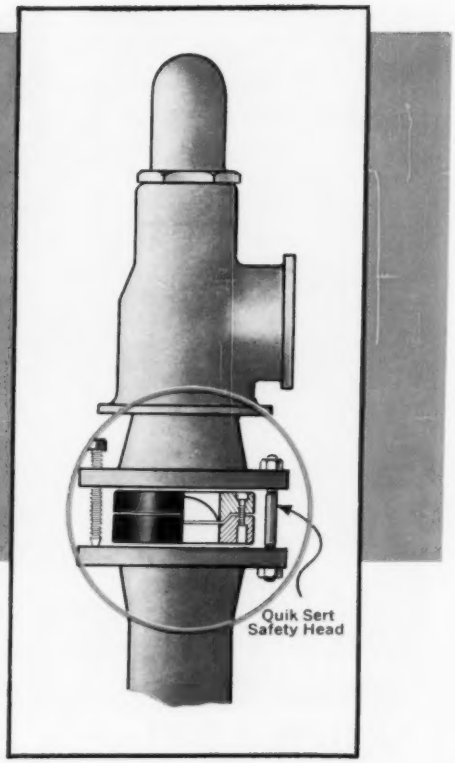
Use a CLASSIFIED ADVERTISEMENT
For Quick Results

You Can Prevent These Three Relief Valve Problems With a BS&B Quik-Sert *Safety Head!*



BEFORE

AFTER



Leakage
Corrosion
"Freeze-ups"

The BS&B Quik-Sert Safety Head isolates the relief valve from the product under pressure. Mounted under the valve inlet, it is "bottle tight" until overpressure reaches the rated pressure of the preformed metal rupture disc.

The Quik-Sert Safety Head flange assembly is located inside the bolting of companion flanges. Easy insertion and removal is accomplished through the use of jack screws.

A BS&B Quik-Sert Safety Head Under the Relief Valve Gives You These Advantages

- Stops product loss at normal operating pressures
- Assures proper valve function at set pressure
- Lowers maintenance costs
- Reduces shutdown time

BS&B engineers will be glad to evaluate your pressure system for proper applications of the Quik-Sert Safety Head.

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ANOTHER EXAMPLE OF PRODUCT LEADERSHIP

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Safety Head Division, Dept. 2-FQ7
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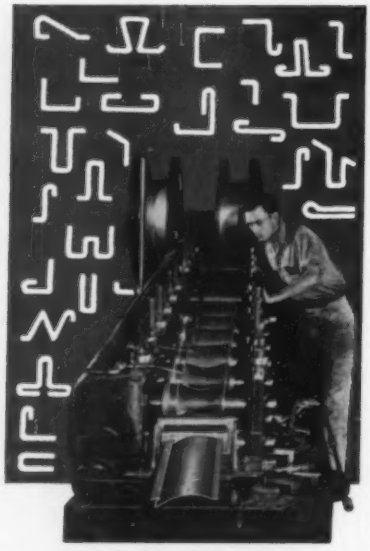
Telephone: BEnton 1-7200



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Cold-roll forming with a Yoder Roll-Forming machine makes spectacular production possible in many metalworking applications and industries.

A multitude of shapes, simple or complex, produced from a wide variety of coated or uncoated stock, and destined for a virtually endless list of purposes, can be easily, quickly and economically produced with a Yoder cold-roll forming machine.

Whether it be moldings, structurals, siding, roofing, tubulars, cabinet shells, or any one of a thousand requirements, it can be quickly produced with accuracy and uniformity the Yoder way. The conversion cost is usually so low that even part-time operation makes a Yoder cold-roll forming line a profitable investment.

A great many modifications of the basic shape such as welding, coiling, ring forming, notching, perforating, embossing and cutting to length, can be simultaneously introduced with little or no additional labor cost. It will pay you big dividends to fully investigate the advantages of Yoder cold-roll forming. A fully-illustrated, 88-page book clearly discusses every important aspect of this amazingly versatile method of metal fabrication... it is yours for the asking.

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ENGINEERING YODER MANUFACTURING
COLD ROLL FORMING MACHINES

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Valve Conversion Unit

C. H. Wheeler Mfg. Co., announces a unit for converting installed valves from hand-operation to electric motor operation.

According to the firm, the unit can be installed without special engineering, disturbing piping or replacing existing valves.

Normal installation consists of six steps which can be performed with ordinary tools. The unit, called Valvmatic, can be used in nearly every application where the valve handle doesn't rise, and where the valve handle can rotate when the valve is operating under power, the company reports. In the event of power failure, the valve can be restored to manual operation by removing two pins.

Position and torque limits are provided in both directions of rotation to prevent valve injury. The unit can be moved from one valve to another, and no special wiring is needed. It is not necessary to remove the valve from the line to install the unit, nor is machining of special valve nuts involved.

—K-13

Heat Exchanger

A line of small rotary, air-to-air heat exchangers which can take waste gases at temperatures as high as 1000 F has been developed by Air Preheater Corp.

About 20 in. in diameter and 11 in. in overall depth, the new compact rotary regenerative heat exchanger can handle flows of 250 cfm. Larger units up to 4 ft in diameter can handle flows as high as 2600 cfm. Efficiencies of 90 per cent or more can be realized, the company says.

Arrangement of multiple units in parallel with common ducting will accommodate flow rates greater than 2600 cfm.

Chief component of the exchanger is the rotor with individual sector shaped baskets that contain the heating element. Seals and sealing surfaces remain plane and parallel to minimize leakage despite severe axial temperature gradient in the heating elements during operation. Drive for the rotary regenerator is a 1/4 hp gearhead motor.

—K-14

To the talented engineer & scientist

APL OFFERS GREATER FREEDOM OF ACTIVITY

APL has responsibility for the *technical direction* of much of the guided missile program of the Navy Bureau of Ordnance. As a result staff members participate in assignments of challenging scope that range from basic research to prototype testing of weapons and weapons systems.

A high degree of freedom of action enables APL staff members to give free rein to their talents and ideas. Thus, professional advancement and opportunities to accept program responsibility come rapidly. Promotion is rapid, too, because of our policy of placing professional technical men at all levels of supervision.

APL's past accomplishments include: the first ramjet engine, the Aerobee high altitude rocket, the supersonic Terrier, Tartar, and Talos missiles. Presently the Laboratory is engaged in solving complex and advanced problems leading to future weapons and weapons systems vital to the national security. Interested engineers and physicists are invited to address inquiries to:

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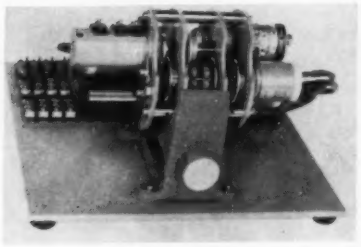


Mechanism Breadboarding

Precision Mechanisms Corp., announces new equipment for breadboarding and test of servo and instrument mechanisms.

The new apparatus consists of stocked components which may be assembled into a virtually unlimited variety of 2⅞ in. diam mechanisms.

As many as six synchro style components of any pilot diameter may be mounted. Standard gear ratios range from 1:1 to 78,125:1. Antibacklash gearing is available in all ratios.

A 48-terminal breadboard mounting assembly clamps the test mechanism by means of a single thumb nut and permits convenient component interwiring, the firm reports.

The fixed gear center mechanisms are designed to provide test results which truly represent the behavior of a correctly designed production unit. Gears are AGMA Precision 1 or better, inertias are low, bearings are ABEC 7 double shielded.

The unit meets the requirements of MIL-E-5400. **—K-15**

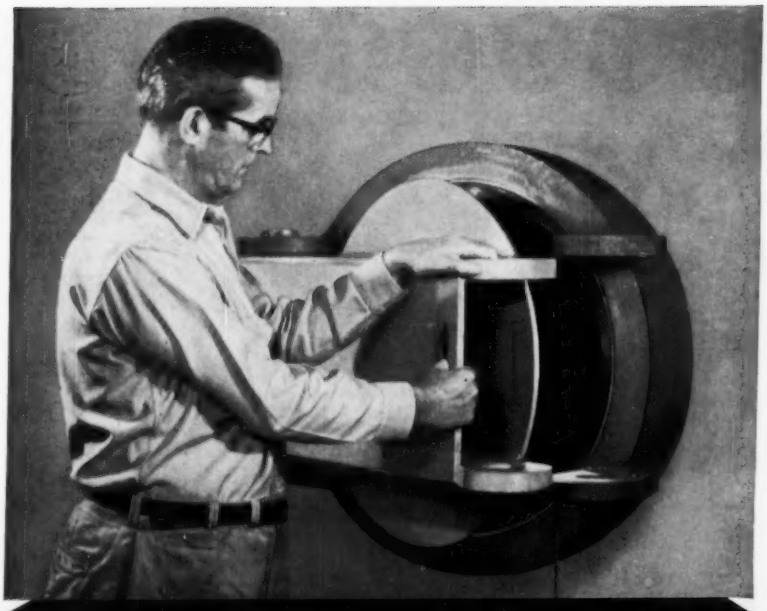
Ladle Addition Feeder

Design of a new and more automatic type of feeder for making ferromanganese or other alloy additions to the ladle while steel is being tapped, has been announced by Equipment Div., Blaw-Knox Co.

The basic feeder consists of a suitable hopper, an electrical vibrating feeder, an adjustable chute and a control panel. Manganese or other alloy additions are fed at a controlled rate through the adjustable chute to the proper place in the ladle.

Main change in the newly designed feeder is that it incorporates one or more hoppers, with each bin having a separate vibratory feeder. Each bin is mounted on load cells of the strain gage type.

The company says that with this equipment it is not necessary to weigh alloys going into the hoppers. Through a control panel, the operator can set the unit to deliver specific amounts of one or more materials to be added to the ladle. The rate at which additions are made is also controlled. When the additions are complete the unit stops regardless of the amount of alloys remaining in the hoppers. **—K-16**



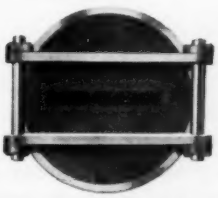
QUICK OPENING · TIGHT SEALING

the LENAPE-LACY MANWAY

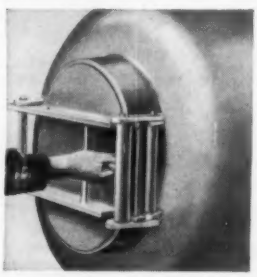
Remove One Pin—and Swing It Open
Close—Drop the Pin in Place—It's Sealed

Here is a manway that anyone can open in a few seconds without tools — yet can't open accidentally. Exclusive Lenape-Lacy design also *provides positive sealing* which seats more tightly with increasing pressure; and the molded gasket of Hycar or silicone rubber can be removed easily and quickly replaced. A protective lip shields the gasket seat from damage.

Three frame styles are available for all normal mounting conditions in ID sizes of 8", 12", 16", 18", 20", 24", and 30" in service ratings of 150 lbs., 300 lbs., 400 lbs., and 500 lbs. Also available for pressure-vacuum cycle service.



Opens in either direction. Other pin acts as a hinge.



For low pressure service, the Lenape-Lacy Latch-Door Manway is widely used. This design employs a unique, quick-opening camlock that permits safe venting of residual pressure before the door is opened. Stocked in 18" ID, 50 psi, plain straight ring frame; also furnished in 16", 18" and 20" 150 psi sizes on any style frame.

Write today for six page Bulletin 576 which describes Lenape-Lacy Quick Opening Manways including complete specifications.

See our standard line of pressure vessel connections on pages 1128-1129 in the 1958 Chemical Engineering Catalog.

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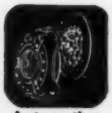
Small Spring Loaded


Automotive Spring Loaded

Heavy Duty Spring Loaded

Oil or Dry Multiple Disc

Heavy Duty Over Center

Light Over Center

Power Take-Offs

Speed Reducers

You get these patented features—in addition to (1) as many as twenty four heat-resistant, non-set springs to assure even pressure all around the plate and long service life (2) nine large side ports and twenty one holes in the cover to carry away heat, dirt, grease and moisture (3) balanced, function-simplified levers to insure efficient operation in high-speed, high-torque engines (4) cushioning and dampening arrangements to minimize shock-load effect and blot out vibration (5) a wide variety of organic, metalic, or Morlife® friction plates. When you specify ROCKFORD you get ALL of these advantages that enable ROCKFORD CLUTCHES to serve better and longer than any "chinese copies".

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Shows typical installations of ROCKFORD CLUTCHES and POWER TAKE-OFFS. Contains diagrams of unique applications. Furnishes capacity tables, dimensions and complete specifications.

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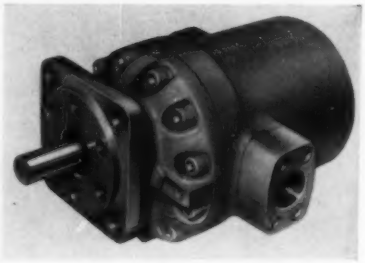

Pump/Motor Units

A new series of hydraulic pump/motor units, designed for 2000–3000 psi industrial service, has been introduced by Berry Hydraulics. A limited number of prototypes for testing are now available to original equipment manufacturers.

The Model A series is a modification of the firm's motor/pump units used in oil, gas, elevator, and lumber industries. The company reports the design has been simplified to provide general industry with rugged, high-pressure motor/pump units at relatively low cost. They may be flange or foot-mounted.

When used as pumps they are for continuous operating pressures of 2000 psi, with surge pressures to 3000 psi. Pumps are available in capacities from 7.5 to 12 gpm at rated speed of 1200 rpm.

The same units are used as motors, providing maximum torque at stall and constant torque output with a flat characteristic curve from 0 to maximum design rpm. Instantly reversible, the motors will carry overhung chain or belt loads. High torque at low speeds permits direct connection without gear or belt reductions. **—K–17**

New Steam Generator

Keystone steam generator, designed as a baffleless, pressurized two-drum water tube packaged unit, has been announced by Erie City Iron Works.

Features of the completely integrated team generating plant, said to require no field piping, wiring, brickwork, or special foundation, are included in a 12-page catalog, designated SB-59. **—K–18**

Ceramic Grate Magnet

Stearns Magnetic Products announces a bulletin covering its new Indox grate magnet for tramp-iron removal. Both wing-type—for floor opening or hopper installation; and drawer-type—for chutes and ducts, are available in single or double bank collecting tube models. Performance advantages of the magnet over ordinary permanent magnet types are discussed, and an explanation of efficiency achieved by continuous-pole magnetization is given. **—K–19**

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BUSINESS NOTES
NEW EQUIPMENT
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Rubber Casting Material

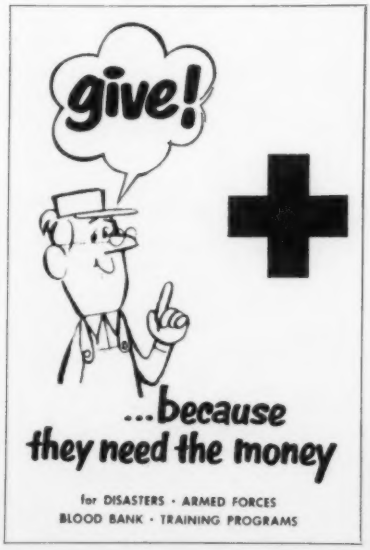
Elastacast, a brand of liquid urethane rubber produced by Acushnet Process Co. is announced as a new casting material developed for use in industrial parts where high load-bearing and long-wearing properties are critical requirements.

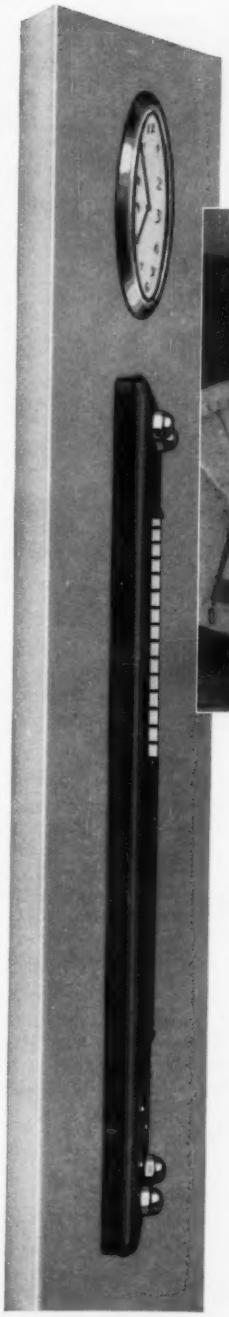
According to the firm, it meets the requirements of a structural material by possessing outstanding abrasion resistance and tensile strength never before attained in an elastomer and for the first time, a combination of hardness, toughness, and resilience.

Parts of unusual shapes, contours and sharp radii without limitations in size can be produced through this liquid casting process, the company states. Many parts can be cast at atmospheric pressure.

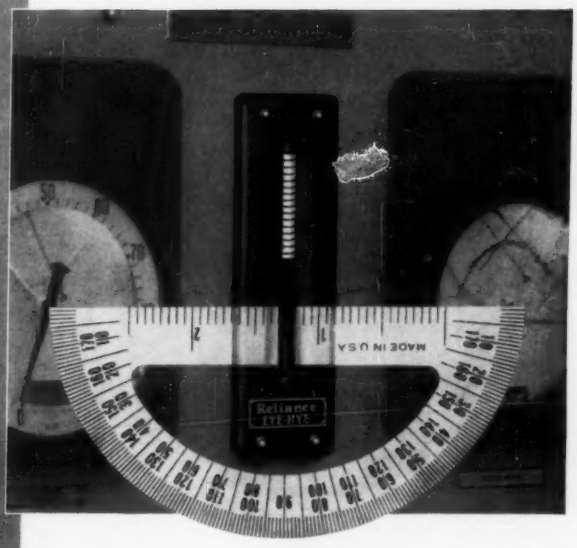
The material can be bonded to metal, and used with or bonded to rigid inserts to provide inexpensive gears, wheels, rollers, platens.

This new material is available in standard formulations covering a range of hardness from 62 to 95 Shore A, having tensile strengths of 4200 to 7300 psi, and having ultimate elongation values of over 500 per cent even with the hardest of these compounds. The firm says materials outside of this range of hardness can be developed for special purposes. —K-20





New Reliance EYE-HYE
gives you 180° reading of boiler water levels



The EYE-HYE can be equipped to actuate additional signals — lights or horns — to warn operators if dangerously low or high levels occur.

Bright green-white image *clearly visible* all around your control room

Wherever you stand in front of your panel — even 90° from center, either side — you can read the picture in EYE-HYE's new protruding window. The brightly illuminated green indicating fluid that spells "water" contrasts sharply with the upper white (steam) section. A new lighting principle brings extra carrying power to the image.

There's no change in the dependable manometric gage principle of operation. EYE-HYE still retains its original simplicity, successful for over 20 years. Thousands of operators prefer the familiar liquid column indication, as in conventional water gages . . . Models are available for any working pressure up to 2500 psi. Write for catalog information — mention your pressure.

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NEW EQUIPMENT
BUSINESS NOTES
LATEST CATALOGS

Teflon Hose Fittings

New Springfield "140" Teflon hose with detachable and reusable industrial fittings has been announced by Titeflex, Inc., an Atlas Corp., subsidiary.

The innercore of the hose is reinforced with stainless steel wire braid to withstand extremely high pressures. The hose is chemical and corrosion-resistant in a temperature range of up to −100 to +500 F. **—K-21**

Overspeed Governor

A new body style for mounting directly on a standard SAE tachometer take-off, thus eliminating the need for a flexible drive cable, is announced by Synchro-Start Products, Inc.

Shank of unit is $1^1/_8$ in. hex with $^7/_8$-18 internal threads for mounting. Tongue drive shaft floats so as to compensate for possible misalignment and is available in diameters of .187 or .152.

The new body style is available for the firm's line of speed sensitive switches which include overspeed, underspeed, two-switch and three-switch governors. **—K-22**

Industrial Adhesives

Cordobond adhesives for metals, plastics, wood, glass, paper, cloth, and leather are now in mass-production, announces the Cordo Chemical Corp.

Bond strength of the plastic-type adhesive approaches and frequently exceeds the strength of the materials being bonded, says the company. It is designed for use in a wide range of different bonding adhesives to meet the exacting service requirements of industry. **—K-23**

Carbide End Mills

Ten new Nelco, Series 400 solid carbide center cutting end mills are announced by Cutting Tool Div., Brown & Sharpe Mfg. Co.

According to the company, the new tools are the only standard solid carbide end mills available that allow plunge cutting and peripheral milling as a single set-up operation. They range in size from $^1/_8$ through $^1/_2$ in.

They are said to be excellent for blind slots as small as $^1/_8$ in., because the center cutting feature completely removes stock on plunge cuts. Sizes larger than $^1/_2$ in. and left hand spiral can be supplied. **—K-24**

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K-10	K-20	K-30	K-40	K-50	K-60	K-70

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KEEP INFORMED

BUSINESS NOTES
NEW EQUIPMENT
LATEST CATALOGS

Miniature Relief Valve

Republic Mfg. Co. has developed a miniature thermal relief valve, called Mini-Relief.

The unit is a trifle longer than the union of the same tube size, as shown in the photo. It is made in tube size 4 (1/4 in.). The set pressure range is 1000 to 4100 psi, and it meets or exceeds the requirements of Military Specification MIL-V-5527, except that it is not adjustable, the company reports.

It is said to be suitable for applications where cracking pressure adjustments are not required. The valves are factory set to any desired pressure within their range, and rated flow at set pressure is .25 gpm. Operating pressure is up to 5000 psi; reseats at 90 per cent of set pressure. The valves have no seals or packings.

Any medium compatible with 18-8 and 440 F stainless steels can be used. Temperature range is −65 to +400 F. The valve is made with MS33514 flareless tube connections as standard, and can be used with Weatherhead Ermeto and Parker Industrial Ferulok connections. The flareless MS33514 connection may also be used in AND10050-4 and similar straight thread O-ring sealed bosses. —K-25

High Temperature Alloy

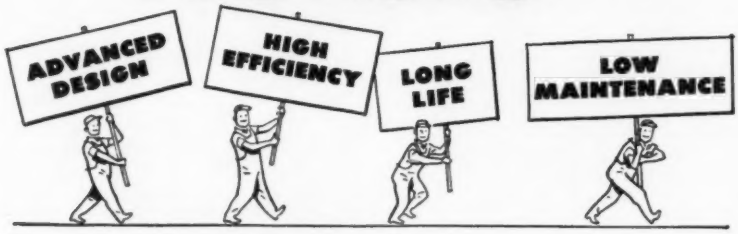
An improved high temperature alloy known as Lapelloy C has been developed by Carpenter Steel Co., for jet engine parts requiring excellent ductility and good impact resistance.

According to the firm, the new alloy has a more homogeneous structure and more uniform fabrication behavior and mechanical properties than its conventional alloys. It is used for highly stressed parts involving service temperatures up to 1200 F.

It is said to have greater ductility and impact strength at both room and elevated temperatures than conventional Lapelloy when heat treated to the same strength level.

High mechanical properties can be developed by heat treatment. It has good resistance to scaling and oxidation for continuous service up to 1400 F. The alloy offers best corrosion resistance when in the hardened and tempered condition. It is used for compressor wheels, turbine shafts, compressor buckets, blades, and bolts, the firm reports. —K-26

Dust Collection Performance is what you buy from Norblo



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Yet Norblo Dust and Fume Collectors are completely modern—up to date. We keep them that way. And we've found it isn't the *model* that interests users . . . it's the *performance* of the equipment we recommend.

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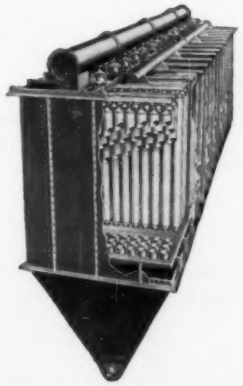
For 45 years Norblo Equipment has supplied outstanding dust arresting and recovery service for the rock products, smelting, chemical, metal working, milling and processing industries. Norblo engineers the complete installation with ample capacity for your needs, with wide adjustability and all the safeguards you may need.

If you have a dust or fume problem, consult Norblo. Write for Bulletin 164 and information form.



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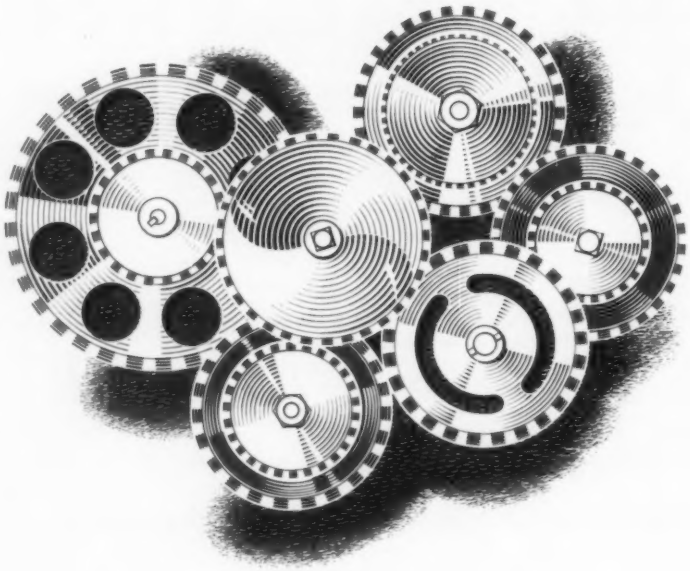

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LATEST CATALOGS

Rotary Air Valve

A 4-way air valve for use with spot welders, pneumatic tools, and other industrial applications, has been announced by Square D Co.

The use of a rotary magnet simplifies design, the firm says, and permits mounting in any position. The new valve can be mounted at the cylinder, eliminating the need for long air lines between valve and cylinder.

Change of direction in the air flow takes place in less than $1/2$ cycle at 60-cycle frequency. Full $1/4$ in. porting is provided throughout. The valve meets JIC specifications, including a chain-attached cover and an oil-tight enclosure. Provision is made for optional manual operation.

It is also available in a special enclosure for mounting directly on gun welder cylinders. **—K–27**

Seamless Steel Tubing

A new application for forged seamless steel tubing, said to reduce parts manufacturing costs substantially, is announced by Ohio Seamless Tube Div., Copperweld Steel Co.

Used to produce rolling mill mandrels subjected to extremes of temperature and stress, the process utilizes swaging and upsetting to form gripper ends on continuous lengths of the firm's Ostuco seamless steel tubing.

First, the tube is swaged to reduce its overall diameter. Second, the swaged end is upset to a larger diameter to provide material for the final forming operation. Then, the preformed end is upset to finished dimensions and the mandrel is ready for use. The new one-piece mandrel replaces a part formerly fabricated from a shaped end hogged out of solid bar stock and welded to a long tube.

The new forging method is claimed to cut mandrel manufacturing costs by one-third. In addition, forged mandrels are superior to the fabricated type in quality and performance, the manufacturer states. **—K–28**

KEEP INFORMED

NEW EQUIPMENT
BUSINESS NOTES
LATEST CATALOGS

Antifriction Bearing Screw

A new antifriction bearing called the Roton bearing has been developed by Anderson Co.

It is designed into nut and screw assemblies to provide highly efficient conversion of rotary to linear movement, and vice versa, covering a wide range of work loads and power inputs.

The assembly is said to present novel new design features including dumbbell-shaped antifriction units which are caged and roll within an annularly grooved nut functioning as the outer race with the helical thread lead of the screw acting as the inner race.

The nut itself is made in one or more parts with the units incorporated into the nut being of sufficient number to meet the load requirements, the firm reports.

Planetary action of the caged units results in a mechanical reduction of linear advancement relative to the thread lead, thereby supplementing speed reducers and gear boxes, or eliminating them when the ratio permits. **—K-29**

Worm Gear Jacks

Duff-Norton Co. announces a new standard line of worm gear jacks, the 1800 series, in capacities of 2, 5, 10, 15, 20, 25, 50, and 100 tons.

The jacks are mechanical devices and will hold heavy loads in position indefinitely without creep, the firm states. The jacks require no adjustment and maintenance costs are said to be much lower than for other types of lifting equipment.

All models have a uniform rate of raise which permits jacks of varying capacities to be operated in unison on unevenly distributed loads. Raises up to 24 in. can be furnished.

The jacks are used on feeding tables, tube mills, welding positioners, rolling mills, testing equipment, conveyor lines, aircraft jigs, loading platforms. **—K-30**

Brake Shoe Coating

A new protective coating for brake shoes, developed by the Raybestos Div., Raybestos-Manhattan, Inc., is claimed to be resistant to all oils, brake fluids, and water, to prevent the shoe from rusting until it is ready to be bonded, and to provide post-bonded protection against rust.

The new product, known as Ray-Bond is applied as soon as the newly manufactured brake shoe is fabricated to protect it from corrosion in storage.

A used brake shoe, after being ground or sandblasted to remove rust, is dipped or sprayed with the protective coating and air dried until not tacky. With new and used shoes, the pre-cemented brake lining is then clamped to the shoe and bonded.

The protective coating is available in three colors—black (R-85001), reddish brown (R-85002), and brown (R-85003). All three are thermosetting, have a synthetic resin base and can be sprayed or dipped on the shoe. If dilution is required, isopropyl alcohol can be used with all three. **—K-31**

Floating Shaft Coupling

Thomas Flexible Coupling Co. has brought out a floating shaft type coupling in miniature sizes.

The floating shaft is held concentric by disc rings at both ends. The extended distance between disc rings permits more misalignment capacity than when disc rings are close together. Shafts may be either solid or tubular.

The firm says this type of coupling can be used with semi-floating type couplings to make long power transmission shafts with a minimum of bearings. It also provides a method of clearing obstructions when two drives are close together; one can be coupled with the standard length coupling and the other with a floating shaft coupling which will stagger the driving units and save space. **—K-32**

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PUMP CLINIC

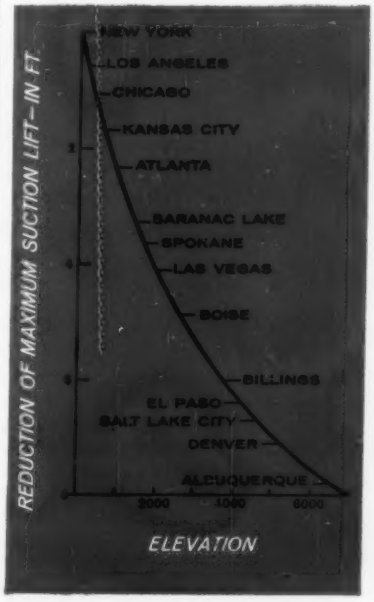
altitude:

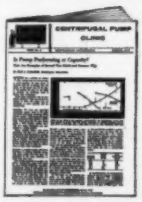
ITS EFFECT ON SUCTION LIFT

Atmospheric pressure — which causes liquids to flow into pump impellers—is reduced by about one inch of mercury for each 1,000 ft. of elevation. As a result, the maximum suction lift of any pump is correspondingly reduced if used in higher altitudes.

When buying a water pump, always specify *altitude* in addition to suction conditions. Your Worthington representative can then select a pump with the correct suction characteristic to operate properly at the required altitude.

This graph shows how suction lift is affected by altitudes of various U.S. cities.





For assistance in solving problems in the operation and maintenance of centrifugal pumps and for useful facts and figures on their selection and installation send for our handy Centrifugal Pump Clinic folder. Write: Worthington Corp., Section 21-1, Harrison, N. J.

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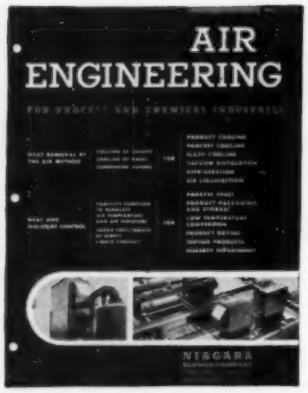

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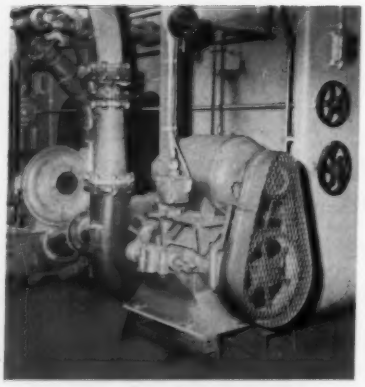
The 6" type "TR" Nagle Ash Pump shown, with motor overhead to conserve space, is aboard the S. S. Harry Coulby, of The Interlake Steamship Company, operating on the Great Lakes. Send for Catalog 5206.



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BUSINESS NOTES · NEW EQUIPMENT · LATEST CATALOGS

Tool Steel

Crucible Steel Co. of America has developed a new tool steel designed for the tool and die industry as an improved shock steel with high toughness at high hardness levels.

Known as LaBelle HT, the new product is a low alloy steel for such applications as shear blades, impact extrusion tools, cold heading dies and punches, and coining and striking dies. **—K–33**

Drafting Film

A new drafting medium called Duracene tracing film, that is expected by the company to replace conventional materials, including cloth, has been introduced by Keuffel & Esser Co. The firm claims the material is so strong it is virtually indestructible and cannot be torn. It is permanent and will not discolor, split, or crack from age or heat. Its uniformly high transparency produces clearer reproductions in a shorter time than other drafting media can, the firm states.

Prime applications include all instances where the preservation of valuable drawings or frequent handling of tracings are involved, the company says, pointing out that its moderate cost and superior characteristics make it suitable, however, for general drafting room use.

The base material of Duracene is 0.003 in. duPont Mylar prepared with a special surface that holds pencil, ink or typewriter work firmly. Work can be erased and done over again in the same area without the risk of ghosting.

The surface of Duracene provides proper contrast for all drawing operations without affecting its reproduction speed. In addition, the material is waterproof and cannot be damaged by moisture or water.

The tracing film comes, coated either one or both sides, in 20 yard rolls in 30, 36, and 42 in. widths. Sheets are also available in special sizes to order, plain or with printed title blocks. **—K–34**

Parts Feeder Components

Syntron Co. announces the availability of its bowl-type parts feeder components for companies developing their own parts-handling systems.

The components include five standard electromagnetic vibratory drive units, and 11 standard sizes of cast aluminum or fabricated steel bowls.

Drive units range from the Model EB-00 which will handle a 5- or a 7-in. diam bowl to the Model EB-3 which takes a 36-in. diam bowl.

Each drive unit is furnished complete with either built-in or separate controls depending upon the model. Standard bowl sizes range from 5 to 36 in. in diam. **—K–35**

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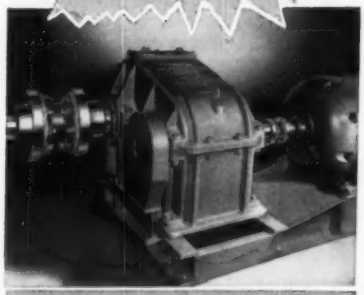

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They will protect your equipment and extend the life of your machines.
Properly installed and operated within rated conditions, Thomas Flexible Couplings should last a lifetime.

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BUSINESS NOTES
NEW EQUIPMENT
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Rotary Air Compressor

A 365 cfm rotary air compressor with an air compressor speed of 1100 rpm has been announced by Le Roi Div., Westinghouse Air Brake Co.

The 365RD2 is the second of a new line of rotary air compressors. It is a portable, two-stage, oil-cooled, sliding vane type compressor rated at 365 cfm of free air compressed to 100 psi.

The compressor is coupled to a GM 471 diesel engine with a hydraulically actuated clutch. Engine speed at rated output of compressor is 1650 rpm. A 100 per cent capacity control matches air supply to the air demand within a pressure range of 10 psi, the company reports.

The engine-compressor is supported on a unit welded steel frame and is enclosed in a heavy steel metal housing of streamlined design. Three-point suspension is designed to protect against damage from towing distortion over rough terrain. Dry weight of the 365RD2 is 7010 lb. Length is 10 ft 5 in., width is 6 ft 8 in., and height is 7 ft 4 in.

Automotive type steering, tapered roller wheel bearings, and 6.50 × 16 8-ply tires are designed to provide safe towing. The towbar has a double spring drawbolt which absorbs both forward and rearward shock and is located at the engine end of the unit. The towbar can be locked in a vertical position for minimum storage dimensions. Safety reflectors are provided at both front and rear of unit.

The side panels are full-length, of quick-fold design, and have full-length piano hinges. Side panels and rear panel are equipped with flush-type latches which can be locked when unit is not in use. Fuel and oil filler pipes and air service valves are inside of the lockable housing. —K-36

Sectional Belt Conveyor

A pre-engineered sectional belt conveyor, featuring bent-plate decking has been introduced by Stepens-Adamson Mfg. Co.

The new packaged unit is complete with head and tail assemblies, supporting A frames, and intermediate sections of bent-plate decking to provide low initial cost and maximum flexibility. The conveyor is available in 18, 20, 24, 30, and 36 in. belt widths, with drives ranging up to 50 hp.

The 12-ft sections are punched with bolt holes every 8 in. in rows on top, bottom, and along its sides. The decking provides its own protection for the return belt run. Return rollers and returning belt are mounted on its underside, shielded from weather and falling material.

The unit is pre-engineered and aligned for erection at job site. Four bolts fasten head assembly; four high strength bolts join intermediate sections; six bolts connect tail assembly. —K-37

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Medium Pressure Boilers
(up to 150 lbs. psi.)

The No. 150 controls the boiler feed pump the one right way—directly from the boiler water level. Holds boiler level within close limits to assure maximum steaming efficiency and fuel economy. Has extra switch which provides circuits for cutting off burner and sounding alarm in case of low water emergency. It's the most widely-used, time-proved control of its kind.

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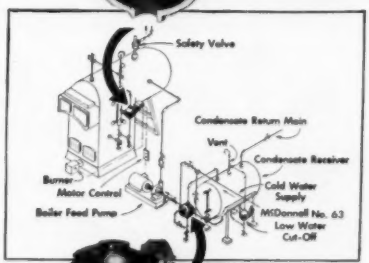
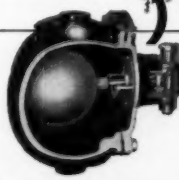
C.S.A. Approval No. 5845
McDONNELL No. 150 PUMP CONTROL





McDONNELL No. 27T MAKE-UP FEEDER

Adds water to condensate receiving tank whenever necessary to make up for any deficiency in returns. Large feeding capacity meets any sudden boiler demand for water. Needle and seat are stainless steel assuring powerful drip-tight closure. For tank pressures to 35 psi., supply pressures to 100 lbs.

Write for simple installation and wiring diagrams

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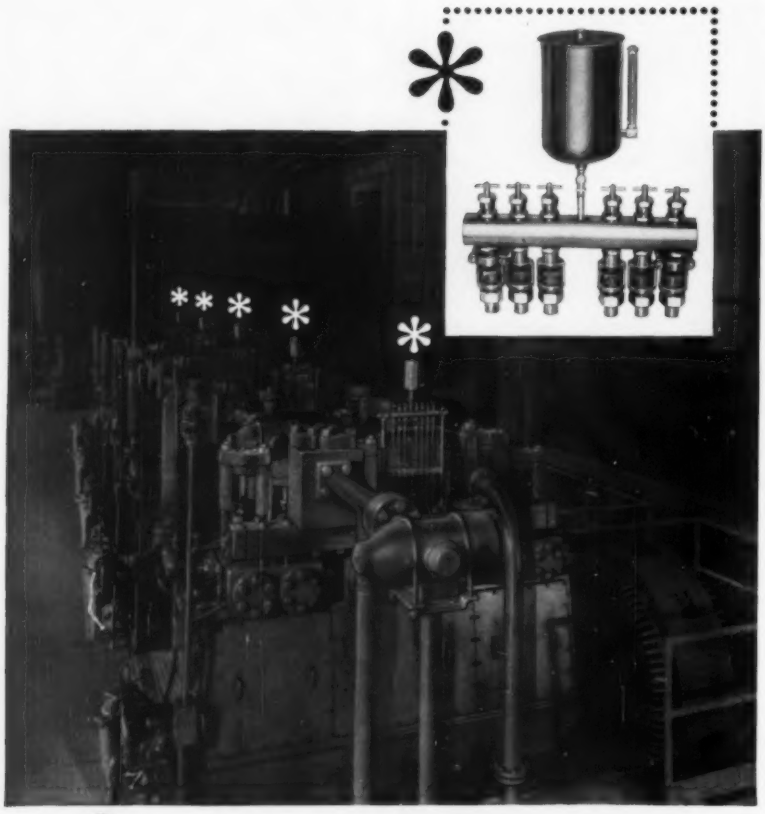
3510 N. Spaulding Ave., Chicago 18, Ill.

Doing One Thing Well
McDONNELL
Boiler Water Level Control
and Safety Devices



NUGENT
MULTIPLE GRAVITY OILERS Provide Controlled Lubrication for hard-to-reach bearings

The five Worthington Power Pumps shown above supply hydraulic power for a central hydraulic accumulator system in a large aluminum mill.

Each pump is equipped with a Nugent Multiple Gravity Oiler. The feeds may be individually controlled to deliver lubrication in predetermined quantities to otherwise inaccessible bearings.

Nugent Multiple Gravity Oilers are available with 2 to 23 feeds. Pressure Sight Flow Lubricators are also part of a full line of Nugent lubricating specialties. Before you decide on any filtration or lubrication equipment . . . see what Nugent has to offer.

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SIGHT FEED VALVES • FLOW INDICATORS

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BUSINESS NOTES · NEW EQUIPMENT · LATEST CATALOGS

Aircraft Fan

Hi-Mode Series D fans, described as a unique design with blades tapered down from hub to tips, are now being produced by The Torrington Mfg. Co., specifically for operation in the extreme vibration environments in aircraft, electronic and missiles applications.

The four- and five-bladed all-aluminum fans, presently available in 6-diam from 4 to 8 in., have been tested without blade resonance under applied frequencies of 1000 cps, well above the requirements of Specification MIL-E-5272A.

According to the firm, the tapered construction of the fan blades has raised the natural resonant frequency of the blades to 1000 cps. This means, the unit not only will not resonate at any external vibration excitation below this frequency but will permit continuous operation of the fan at higher speeds and consequently higher air outputs. For example, the company says, structural failure of a four-bladed fan usually occurs when the second and fourth harmonics of rotational frequency coincide with the natural blade frequency of the fan. At a speed of 11,000 rpm, these harmonic frequencies are 366 and 732 cps, respectively, well below the first natural mode of vibration of the Series D fan design. **—K-38**

BUSINESS NOTES

Company Established

Establishment of Navan Products, Inc., as a wholly-owned subsidiary, has been announced by North American Aviation, Inc.

The new firm, which will have its headquarters in Santa Monica, Calif., will be a marketing and licensing organization, handling specialized products which have been developed by divisions of North American or other companies.

Pump Business Acquired

The hydraulic pump and fluid motor business of the Gerotor-May Co., Baltimore, will become a part of the Hydraulics Div., Brown & Sharpe Mfg. Co., of Providence.

The firm says it will now be in a position to provide completely engineered hydraulic circuits for the industrial field, built exclusively of components of its own manufacture. Applications for such equipment include controls for automated machine tools, mobile equipment, missile launchers, the company said.

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BUSINESS NOTES
NEW EQUIPMENT
LATEST CATALOGS

Acquires Controlling Interest

Lovejoy Flexible Coupling Co. producer of power transmission equipment, has acquired controlling interest in Hi-Lo Manufacturing Co., formerly Equipment Engineering Co. of Minneapolis, Minn., W. H. Dangel, Chairman of Lovejoy, announced. Hi-Lo, manufacturer of variable speed pulleys, will continue operations in Minneapolis under the presidency of V. G. Nordley. The sales headquarters will be in Chicago.

Powder Metallurgy Plant

Bound Brook Oil-Less Bearing Co., will build an ultra-modern powder metallurgy fabricating plant at Sturgis, Mich., according to an announcement jointly with the Michigan Dept. of Economic Development.

The million dollar plant will be geared to high volume production of sintered bearings and parts, and will use various fabricating methods developed by the firm's engineers. Construction will be completed later this year.

LATEST CATALOGS

Fittings, Flanges

A new folder released by Tubular Products Div., Babcock & Wilcox Co., known as Bulletin FB-504, explains how the user will save time and money by ordering fittings and flanges which are produced to close dimensional tolerances. **—K–39**

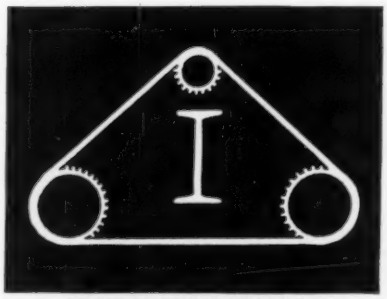
Manual, Solenoid Valves

Barksdale Valves announces a 56-page catalog on characteristics, selection, and application of valves.

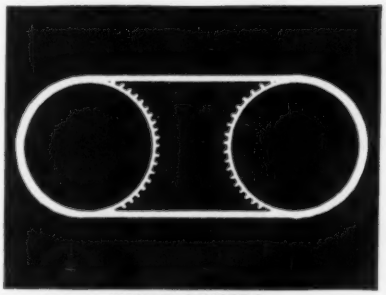
Valves illustrated are rated for oil and water pressures from 0 to 250, 0 to 1500, 0 to 3000, 0 to 6000, and 0 to 10,000 psi, and air pressures from 0 to 250, 0 to 1000, 0 to 2000, 0 to 4000, and 0 to 10,000 psi, in four way, three way, shut off, and diverter flow patterns, manual and solenoid. **—K–40**

ALWAYS NEEDED

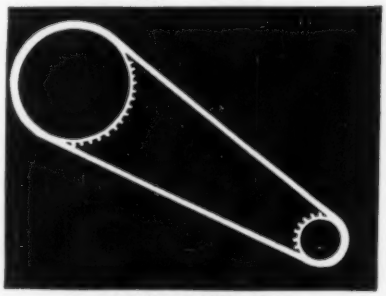
ALWAYS THERE



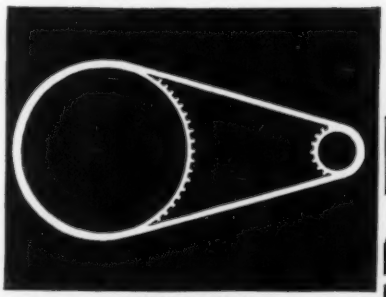
AROUND OBSTRUCTIONS



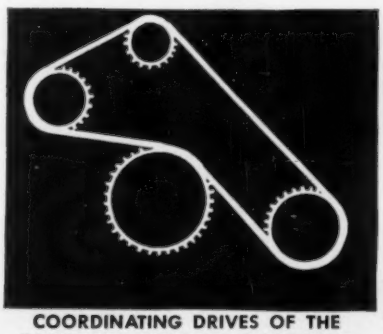
SHORT CENTERS



LONG CENTERS



HIGH RATIOS



COORDINATING DRIVES OF THE SAME AND OPPOSITE DIRECTIONS

Is the answer to your drive problem here?

Diamond Roller Chains, Conveyor Chains and Sprockets are non-slip, adaptable precision drives. Their unusual flexibility, high strength, light weight, compactness and 98 to 99% efficiency mean they are extremely versatile and solve many drive problems easily and at low cost.

Use Diamond Roller Chains now. Capacities from fractional to thousands of horsepower, high speeds or low. Also ideal for counterweight, hoist and lift applications.

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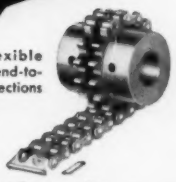
Please refer to the classified section of your local telephone directory under the heading CHAINS or CHAINS-ROLLER



Diamond Flexible Couplings for end-to-end shaft connections to 725 H.P.

Diamond Sprockets finished bore, minimum bore and taper lock types.

Write for your copy of New Catalog 757

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AURORA Always PUMPS

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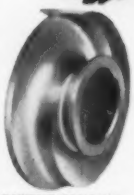
HORIZONTAL & VERTICAL
MONO-VANE
SINGLE PASSAGE IMPELLER
PUMPS



PATENT PENDING

The response to our new MONO-VANE Non-Clog Pumps was instant and gratifying. We thought you, too, would find interest in this STEP FORWARD in non-clog pumping technique.

NO SEPARATE COUNTER-BALANCE IS REQUIRED

Other head and capacity requirements by the mere trimming of the impeller. The impeller is ALWAYS in DYNAMIC and HYDRAULIC BALANCE—a major advance in non-clog pumping.

Handles solids passing up to 3" diameter spheres

●

Trouble-Free Performance — Convenience and Lasting Economy

●

Discharge may be turned to any position — accessible for cleaning

●

Smooth, Quiet Operation

These advanced pumps with the exclusive Aurora Mono-Vane Impeller are available in both horizontal and vertical types with 3" to 5" (suction-discharge diam.) Discharge may be turned to various positions. Cleanout openings provided. Detachable covers for ready access.

Type KGG
Horizontal Mono-Vane Non-Clog Pump

Type KU Aurora
Vertical Mono-Vane
Non-Clog Pump

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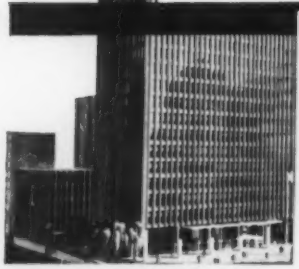
How to **silence**
38 stories of piping

Figure 329 Valve, center-guided type.

In the new Seagram Building in New York, Williams-Hager Silent Check Valves control water hammer. They silence and protect piping by operating instantly when flow reversal starts or when flow is zero. Just one of hundreds of outstanding buildings protected by Williams-Hager Valves.

Write for Bulletins

—No. 654 on Valves, No. 851 on Cause, Effect and Control of Water Hammer



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CHECK VALVES

Architects: Mies van der Rohe & Philip Johnson. Associate Architects: Kahn & Jacobs. Consulting Engineers: Jaros Baum & Bolles. General Contractor: George A. Fuller Company. Plumbing Contractor: Eugene Duklauer Inc.

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149 Stanwix St. • 2 Gateway Center • Pittsburgh 22, Pa.
Our 72nd Year . 1886-1958

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BUSINESS NOTES
NEW EQUIPMENT
LATEST CATALOGS

Variable Speed Units

Revco, Inc., announces literature covering its infinitely variable speed reducer and control.

The mechanical unit is designed in 35 basic models available with or without motor, reverse, or gearhead. An additional bulletin describes new heavy duty motorized units from 0 to 400 rpm. **—K-41**

Dust Control

A bulletin describing the operation and application of its equipment in asphalt plant dust control is available from American Air Filter Co.

Bulletin 270-A2 includes photographs of installations which illustrate how different combinations of dust control units can meet specific job requirements. The basic units featured are skimmer, the AMERclone, the Type N Roto-Clone and Type K exhauster. **—K-42**

Compressors, Gas Turbines

A composite catalog issued by Clark Bros. Co., one of the Dresser Industries, covers selection of compressors and gas turbines by application requirements and unit engineering.

The 40-page catalog features the firm's line of standard products, giving engineering and performance data with reference to the petroleum, refining, gas, pipeline, chemical, petrochemical, and other industrial applications. **—K-43**

Filters, Regulators

Hannifin Co. Div. of Parker-Hannifin Corp., offers sets of layout tracers designed to make it easy to lay in the various units of its Crown line of filters, regulators, lubricators, and accessories.

Outlines of the various units are shown to scale on permanent cards which the draftsman slips under his tracing. There are eight cards (16 sides) in the set, which comes in a special envelope with directions for use. **—K-44**

Space Technology

Applied research in space technology, plasma dynamics, and hypersonics is described in a new booklet published by the General Electric Co.

Each of the five principal operations in the G-E Missile and Ordnance Systems Department's Aerosciences Laboratory at Philadelphia is summarized in the sixteen page booklet. Included are detailed drawings of a new 6-in. diam, 134-ft long shock tunnel and picture caption summaries of research activity in gas arcs, recombination rates, plasma acceleration, material emissivities, high temperature radiation and gas-phase chemical reaction. **—K-45**

KEEP INFORMED

BUSINESS NOTES
NEW EQUIPMENT
LATEST CATALOGS

Vibration Generation Systems

An eight-page bulletin, called C10 series, describing complete complex motion and sine wave vibration generating systems, for use by aviation, missile, and rocket design and test engineers engaged in precise vibration analysis, is announced by MB Mfg. Co., Div. of Textron Inc.

Technical information and illustrations on vibration exciter, amplifier, control console, and compensation console—including references for detail specifications, blueprints, and performance charts—are described. Random and complex motion set-up procedures and equilization techniques are discussed with examples of performance with specimens of various weights. —K–46

Dust Collector

A six-page bulletin describng a new aerostatic dust collector has been released by Hagan Chemicals & Controls, Inc.

The collector is designed for use in air pollution control, and for product recovery in cement, metal, oil, milling, sintering, foundry and chemical plant processing operations. The brochure attributes the collector's resistance to erosion, and unusually high efficiencies, to a unique design of the venturi-spiral vaned nozzles at the inlet of each separating tube. This design differs from conventional centrifugal collectors in that the vaned inlets decrease in two dimensions simultaneously—axially and radially, to produce intense separating forces on entrained dust particles. —K–47

Bronze Flexible Connectors

A bulletin released by Universal Metal Hose Co., provides specifications and prices on its line of bronze flexible connectors designed to convey gases or fluids at temperatures up to 400 F.

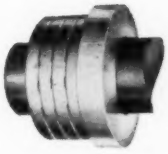
The units are leak proof and highly corrosion resistant. The outer cover is braided for extra strength. Such connectors are used to simplify misaligned hook-ups and to provide a flexible connector that will compensate for expansion or vibration. Flanged, solid male and female union connections are available, and inside diameters range from 1/4 to 4 in. —K–48

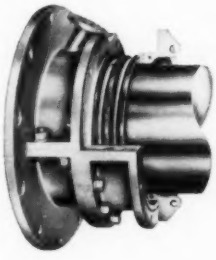
Flow Tubes

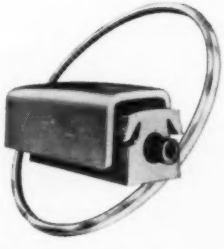
A 20-page bulletin giving technical data on the design, the metering characteristics, flow formulas, capacity and accuracy, installation information, accessory items, and sin ilar engineering information on the Dall flow tube is now available from Builders-Providence, Inc., Div. of B-I-F Industries, Inc.

The bulletin is illustrated with photographs, sketches, charts, and graphs. —K–49

SYNTRON Mechanical
SHAFT SEALS
can solve all your sealing problems







Install SYNTRON Shaft Seals and forget them. No shutdowns for periodic adjustments or maintenance. They are completely self contained — ready to install. All Sealing faces are precision lapped to provide a positive leakproof seal — will not score or gall shaft.

Whether your problem involves high speed shafts or temperatures, corrosive liquids, synthetic fluids, toxic gases, oil, sea water or just ordinary water . . . There's a SYNTRON Shaft Seal to solve it.

SYNTRON builds positive sealing Mechanical Shaft Seals for every rotating shaft requirement, regardless of shaft size.

Write for information on SYNTRON'S Anti-Friction, Face-Type, oil and roll neck seals.

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Syntron can help you with problems involving . . .

Vibrators (bins, hoppers, chutes)	Rectifiers (Silicon and Selenium)
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Vibratory Screens	Electric Heating Panels
Shaker Conveyors	Electric Heating Elements
Vibratory Elevator Feeders	Sinuated Wires
Weigh Feeders	Shaft Seals
Packers and Jolters	Electric Hammers
Hopper Feeders	Concrete Vibrators
Lapping Machines	Paper Joggers

Our representatives will be glad to work with you in selecting the proper equipment for your operation.

Call your nearest Syntron representative

For more information write for complete catalog . . . Free

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OPW Loading Assemblies have long been known for their really effortless flexible loading, practical compactness, maneuverability and long service life.

FREE CATALOG F-32R provides a detailed study of OPW's Spring-Balanced and Counter-Balanced styles, in addition to engineering data, components, and a wide range of applications.

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AND A CHECK
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NEW EQUIPMENT
BUSINESS NOTES
LATEST CATALOGS

Bronze Valves

Illustrated literature on its 150-lb WSP bronze globe, angle, and check valves has been issued by the Walworth Co.

The bulletin contains service ratings, dimensional drawings for each type valve and an exploded view of a globe valve with matching text for each component. Bronze renewable disk valves in the firm's 150-lb lines feature hard composition, all-purpose disks suitable for use with temperatures up to 500F and resistant to oil and gasoline at atmospheric temperatures. **—K-50**

Pneumatic Pull Tools

A six-page catalog, Form 8-421, describing its line of standard pneumatic pull tools for fastener installation is available from Huck Mfg. Co.

The new catalog lists pneumatic pull tool nomenclature and describes in detail each of the five basic pneumatic units available. A ready-reference table is provided for determination of the fasteners that can be installed with each pneumatic tool. **—K-51**

Aluminum Fabricating

A booklet describing the engineering services and metalworking tools available in Aluminum Co. of America's jobbing facilities has been announced.

The 14-page booklet depicts the company's diversified skills and equipment for designing, forming, joining, and finishing aluminum jobbing products. Included in the more than 50 illustrations are action photographs of several of the operations' wide range of presses, plus views of aluminum forming operations. **—K-52**

Impulse Steam Traps

Yarnall-Waring Co. announces Bulletin T-1742 (57), giving information on its line of impulse steam traps. Typical installations for all series are shown with dimension, capacity, weight, and price lists.

Included are data on Series 60 and 120 traps for normal condensate loads at pressures to 400 and 600 psi, temperatures to 450 F and 650 F; Series 20-A and 120-A traps for the same maximum operating temperatures and pressures but with lower condensate discharge capacities; and the Series 40 traps for extra heavy condensate loads at up to 750 F. **—K-53**

Hose Swivels

A four-page bulletin, F-43, describing its line of hose swivels, is announced by OPW Corp. of the bulletin includes cut-section illustrations, product specifications, application information, and other descriptive data. Hose swivels are used in hose and piping systems to give free, flexible movement, the company reports. They are designed to prevent torsional strain, prolong hose and pipe life. **—K-54**

Overload Protector

Machine Accessories, Inc., Subsidiary of Revco, Inc., has available a bulletin describing its mechanical overload protector.

The unit is a positive drive with slip clutch action for use between two shafts. When driving, three spring steel fingers, internally attached to the driving shaft are engaged in depressions of the hardened steel back plate which is internally attached to the driven shaft. The connection is broken when the rating is exceeded, and the finger automatically reset when the overload has been corrected. **—K-55**

Timing Belts

A timing belt drive catalog, TB-58, announced by Morse Chain Co., gives information on five basic timing belt pitches.

In addition to engineering information, the new catalog covers the following pitches: $^1/_5$, $^3/_8$, $^1/_2$, $^7/_8$, and $1^1/_4$ in. It contains information on selection, installation, and use. **—K-56**

Pulse Generators

Application engineering data sheet E-57-2, describing the use of pulse generators to recirculate gases for reforming and hydrogenation processes in multiple-purpose pilot plants, is available from Milton Roy Co.

The data sheet contains four pages explaining how the pulse generators accurately meter and recycle light gases without leakage to avoid inaccuracies in pilot plant flow rates. **—K-57**

Dust Collection

A four-page bulletin offering specifications and descriptive details on the firm's hydrofilter is available from National Dust Collector Corp.

Covered are details on how the wet type collector uses the filtration principle to trap dust by impingement on glass spheres; entrapment on bubble surfaces and containment within water droplets. Application data, construction and design specifications; a description of models and capacity range available; and a description of laboratory and test facilities are included. **—K-58**

Venturi Meter Tubes

A technical bulletin describing the various types of venturi tubes, their recovery characteristics, the formulas that determine their design, typical calculations, and similar data is now being offered by Builders-Providence, Inc., Div. of B-I-F Industries, Inc.

The bulletin includes a discussion of aspects to be considered in venturi design, installation instructions, the economics of venturi metering, the various accessories available, and complete specifications. It is illustrated with diagrammatic sketches, comparison charts and graphs, installation drawings, dimensional data, and capacity tables. **—K-59**

KEEP INFORMED

BUSINESS NOTES
NEW EQUIPMENT
LATEST CATALOGS

Diazotype Reproduction

A 12-page illustrated booklet describing the firm's Copyflex diazotype reproduction process is available from Charles Bruning Co., Inc.

The booklet explains the various types of direct-positive prints possible with the process, including black-line or color-line prints on white or tinted stock; multicolor films for projection and overlays; translucent duplicate originals; dimensionally stable film and glass cloth prints; and reflex prints on translucent film. —K–60

Hydraulic Servo Drives

A 12-page bulletin that treats hydraulic servo drives for weapons systems developed and produced during the last 20 years is available from Vickers Inc.

Featured is the precision response to a small signal characteristic of servo hydraulics and electro-hydraulic systems. Radar directed airplane gun turret controls, power boost flight controls, anti-aircraft gun drives, guided missile radar drives, jet bomber gun turret drives, missile hydraulic power (airborne, launching, ground handling, and check-out), and a dynamic fire control simulator are among the applications illustrated. —K–61

Couplings for Guided Missiles

Snap-Tite, Inc., has issued a 26-page catalog describing its special quick connect/quick disconnect couplings for guided missiles and aircraft use, and other exceptional applications.

Most of the special couplings shown feature remote disconnection which can be by either solenoid or lanyard action, but emergency manual disconnect can also be provided, the firm reports. —K–62

Pressure Gages

Callery Chemical Co. has available a folder illustrating and describing its high temperature pressure gage, Model C.

The unit is designed for constant high temperature operation to 1000 F, on a-c current from 60 to 400 cycles, for remote indicating or recording applications. —K–63

Ceramic Insulated Wire

Aero Research Instrument Co., annnounces Bulletin No. 4, describing its ceramic insulated wire, called Aeropak, for use in atomic reactors where a permanent installation is required for thermocouple leads, power leads, low level instrument signals and resistant elements.

It is said to be particularly applicable for use in high radiation fields at high pressure and low and high temperatures −400 to +2000 F. It is available in several sheath diameters from 0.025 to 0.31 in., multiple conductors, and a variety of sheath and conductor materials. —K–64

NEW-

JUST OFF THE PRESS

This new Bulletin, with 182 photographs, diagrams and tables, is a handbook of refrigeration in all its commercial and industrial phases—air conditioning, ice making, quick freezing, cold storage, process work, etc.

Details of heavy-duty compressors, multi-cylinder compressors, booster systems, condensers, coolers, coils, controls, valves and auxiliaries are fully explained.

If your business uses cooling equipment, you'll profit from reading this informative 32-page booklet. Available in English, Spanish and Portuguese. Your free copy is waiting.

THE "BIBLE" OF AIR CONDITIONING & REFRIGERATION PRACTICE

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NEW EQUIPMENT BUSINESS NOTES LATEST CATALOGS

Pumps, Flow Meters

MSA Research Corp. has available a bulletin describing its a-c electromagnetic pump, conduction type, for constant high temperature operation to 1000 F. The unit operates from single phase 50 or 60 cycle a-c voltages.

The firm has also released a data sheet on its liquid metal flow meter which operates on the principal of a generator to measure the flow of liquid metal which has an electrical conductivity. —K-65

Stainless Castings

Stainless castings with unusual hot strength are described in a bulletin offered by Nuclear Products Div. Copper Alloy Corp.

It discusses the methods and procedures used to obtain castings with strengths 20 per cent higher than required by the code for unfired pressure vessels and the significant economies found in their use. Material comparison data is furnished in tables and photographs of the various products are shown. —K-66

End Mills

Fourteen corner rounding shank type end mills have been added to the standard line of cutters available from Cutting Tool Div., Brown & Sharpe Mfg. Co.

Sizes range from $^1/_{16}$ to $^1/_2$ in. radius and are available individually or in a set of eight, mounted in a wooden block. The new, shank type cutters are said to be especially versatile for rounding corners where arbor type cutters make working area inaccessible. —K-67

Metal-Clad Switchgear

A booklet, entitled "Shelterfor-M, The Modern Approach to Substation Design," is offered by Westinghouse Electric Corp.

The booklet emphasizes the principal features of what it describes as a new concept in outdoor metal-clad switchgear. The booklet explains how the features achieve space savings, and protection of equipment and personnel from the elements. Grouped in several sections, the discussion includes: flexible arrangement, camouflage, roomy work area and all-weather protection.—K-68

Gaskets, Stampings

Metallo Gasket Co., announces a 20-page catalog illustrating and describing its gaskets, metal stampings, special gaskets, valve disks, raschig rings, and lessig rings.

In addition, information on the company's engineering and production facilities is provided. Photos of the various sizes and shapes of products made by the company are included, along with specifications and dimensional information. —K-69

Cushioned Valves

Golden Andersen Valve Speciality Co., announces four bulletins illustrating and describing its cushioned valves.

Bulletin S-3A covers an automatic engine stop valve; W-14, emergency cut-in valve; W-11, rubber-lined swing check valve; and G-5 gives general information on the operation and application of various types of relief, altitude, check, and pressure reducing units. —K-70

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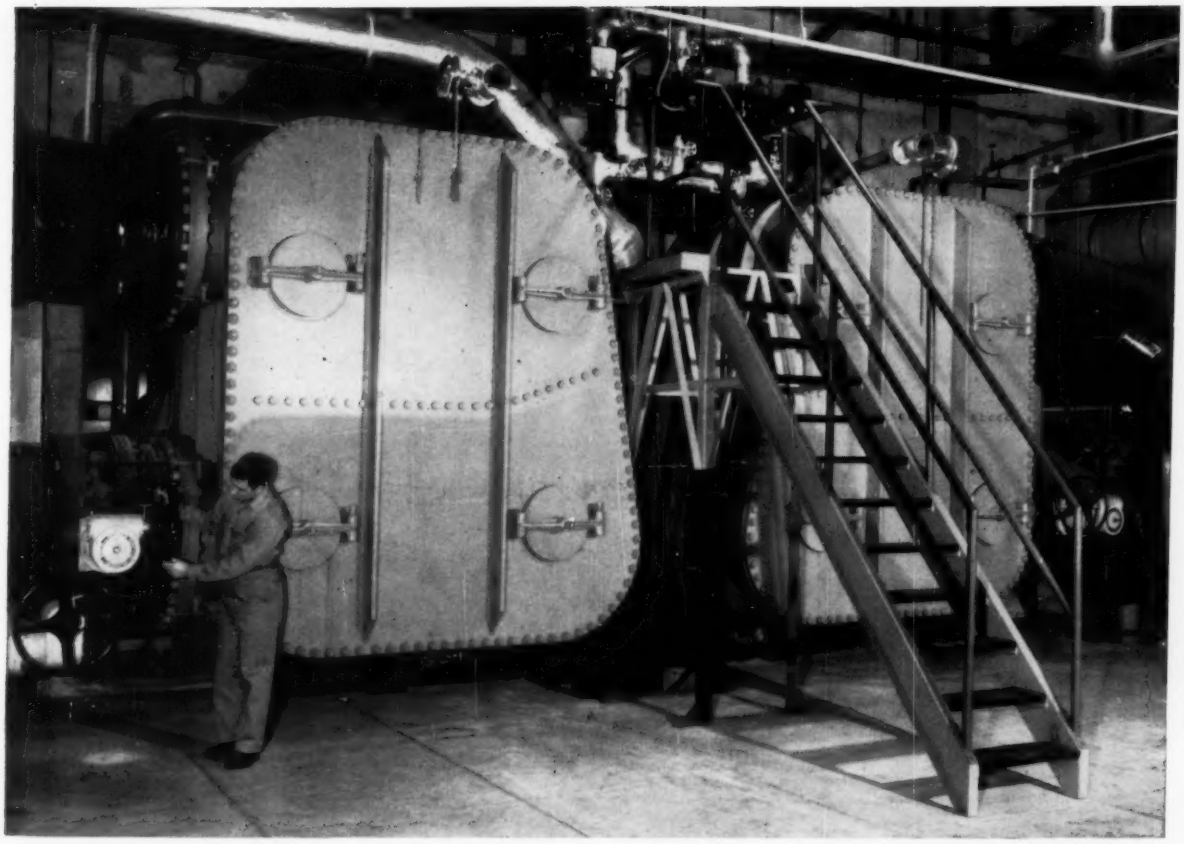

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PLUS PERFORMANCE FROM YUBA CONDENSERS

Performance tests made by the Indianapolis Power & Light Company on this 50,000 sq. ft. Yuba surface condenser a year after it was installed in their H. T. Pritchard Station showed zero oxygen content in the condensate. The temperature of the condensate was found to be 3.9 degrees higher than the temperature corresponding to saturation pressure. Heat transfer was 106.6% of design.

Magnificent performance such as this is far in excess of guarantees and it proves once again that there are great plus values in Yuba equipment.

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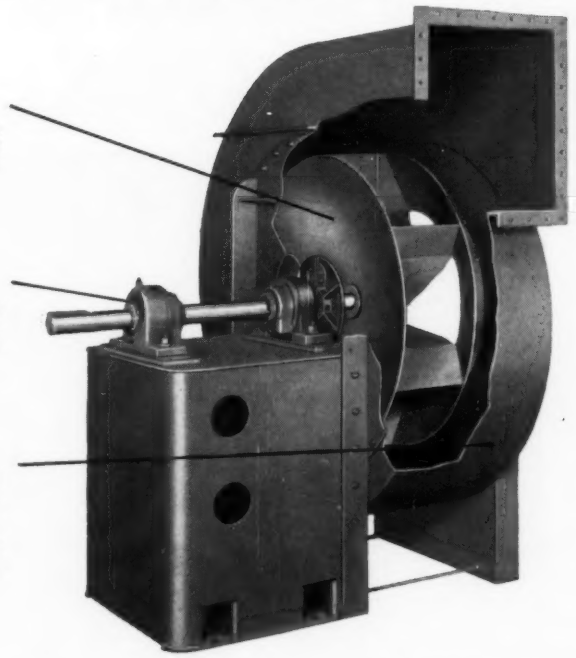

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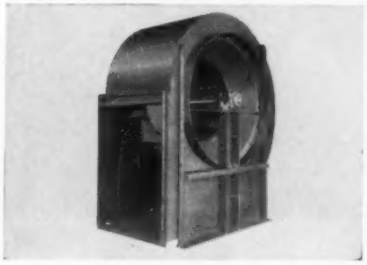

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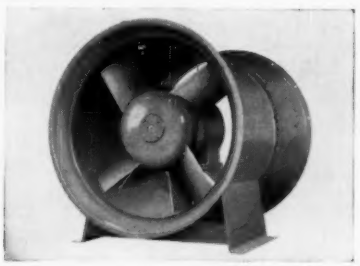

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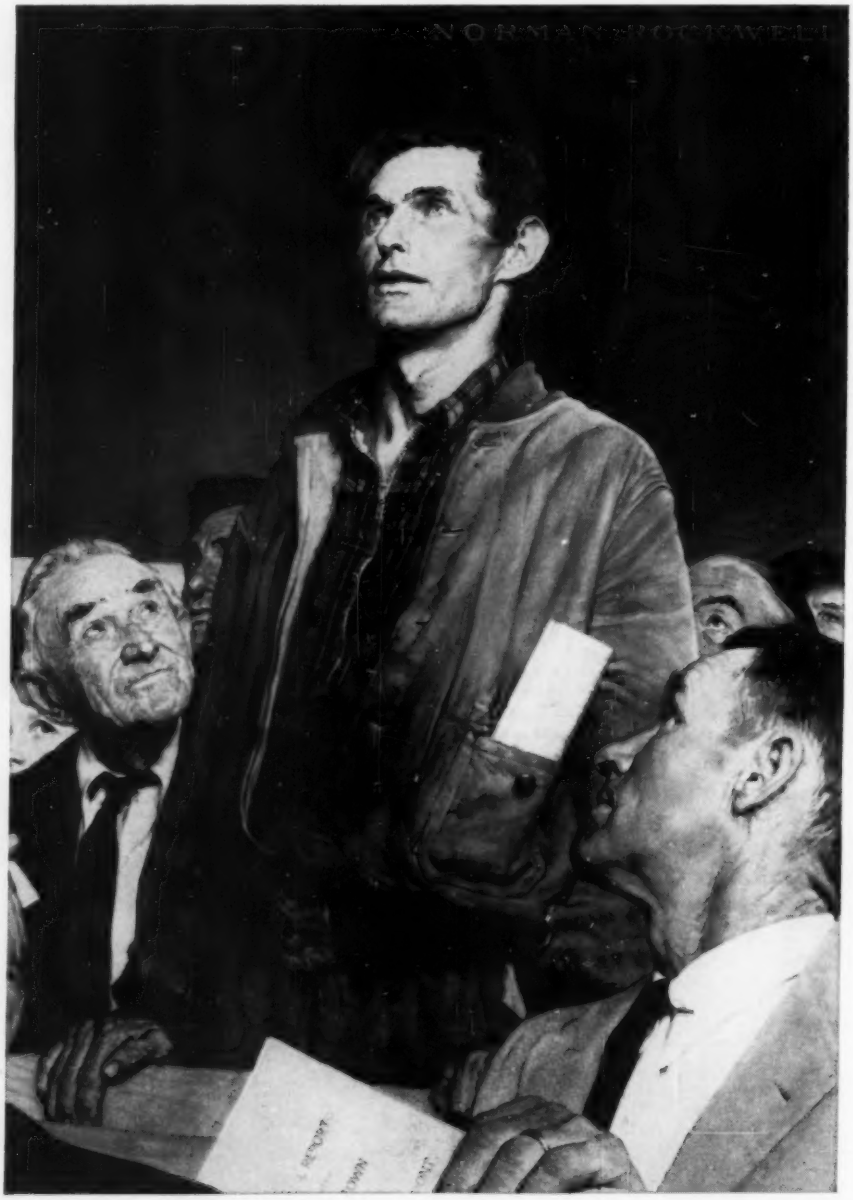

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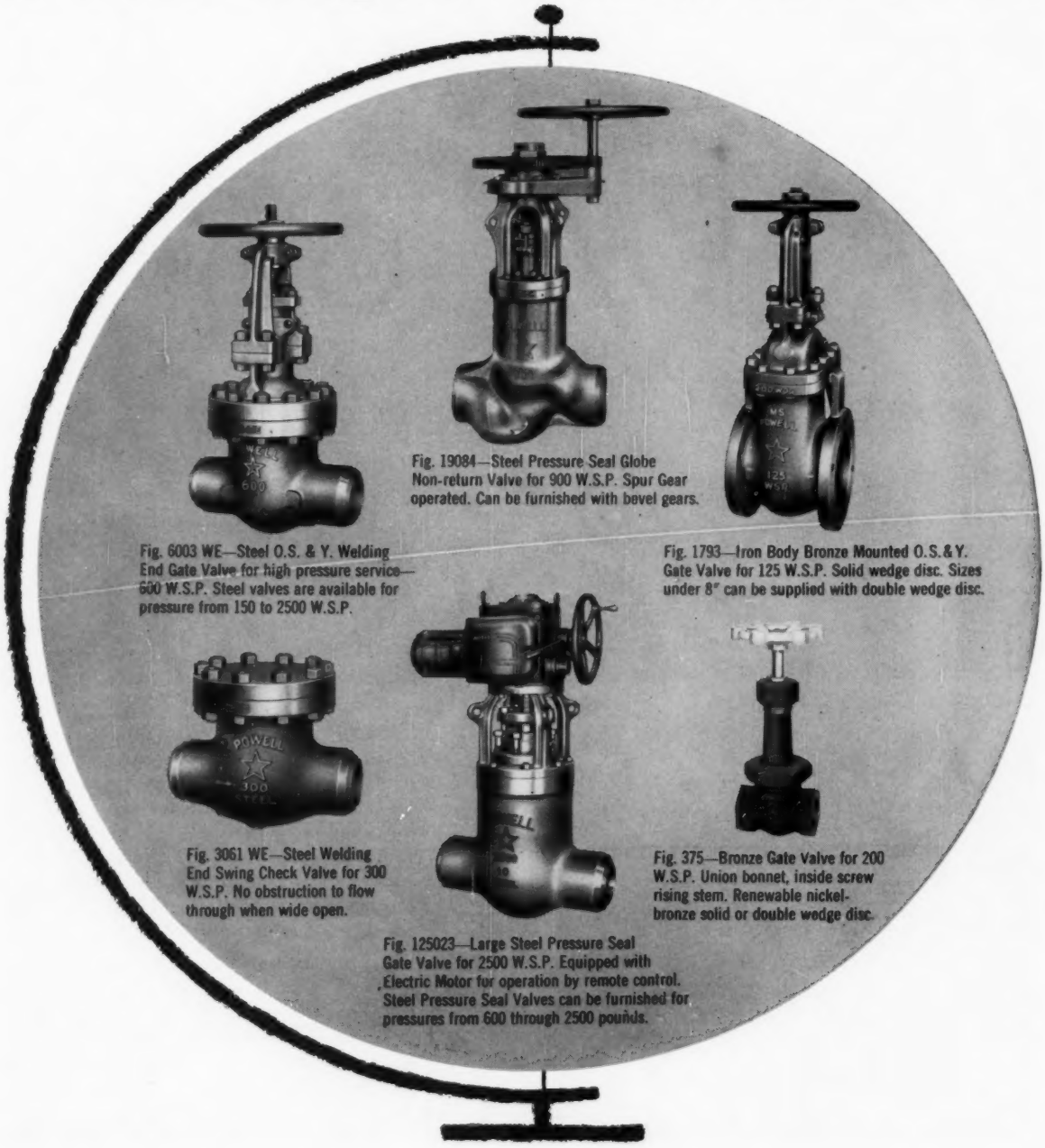

Fig. 19084—Steel Pressure Seal Globe Non-return Valve for 900 W.S.P. Spur Gear operated. Can be furnished with bevel gears.

Fig. 6003 WE—Steel O.S. & Y. Welding End Gate Valve for high pressure service—600 W.S.P. Steel valves are available for pressure from 150 to 2500 W.S.P.

Fig. 1793—Iron Body Bronze Mounted O.S.&Y. Gate Valve for 125 W.S.P. Solid wedge disc. Sizes under 8" can be supplied with double wedge disc.

Fig. 3061 WE—Steel Welding End Swing Check Valve for 300 W.S.P. No obstruction to flow through when wide open.

Fig. 375—Bronze Gate Valve for 200 W.S.P. Union bonnet, inside screw rising stem. Renewable nickel-bronze solid or double wedge disc.

Fig. 125023—Large Steel Pressure Seal Gate Valve for 2500 W.S.P. Equipped with Electric Motor for operation by remote control. Steel Pressure Seal Valves can be furnished for pressures from 600 through 2500 pounds.

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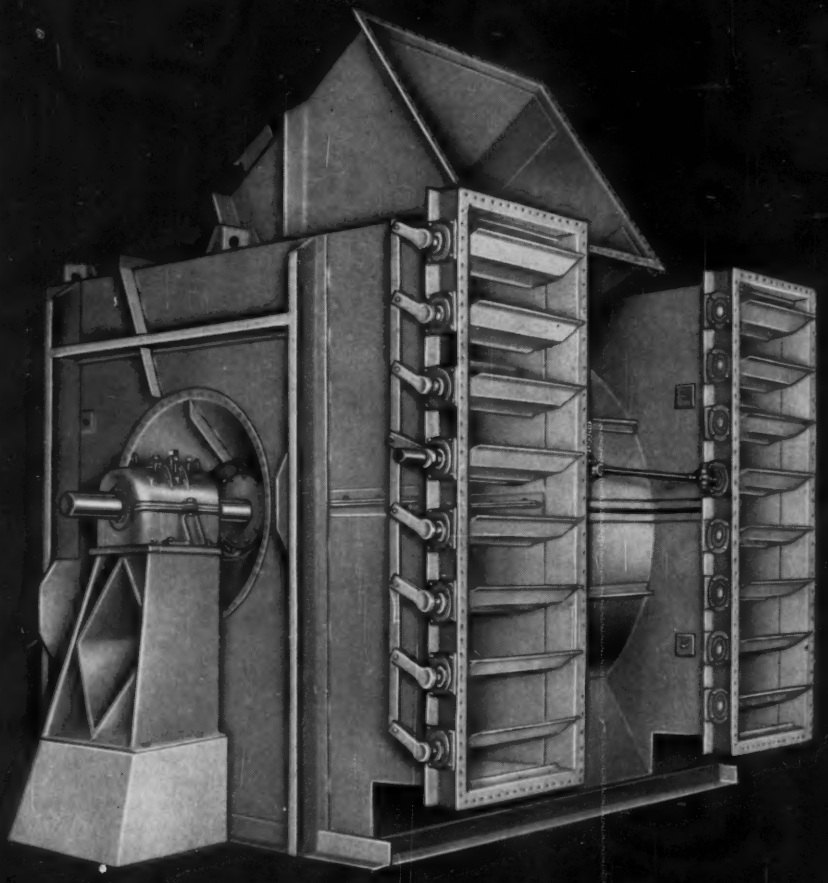

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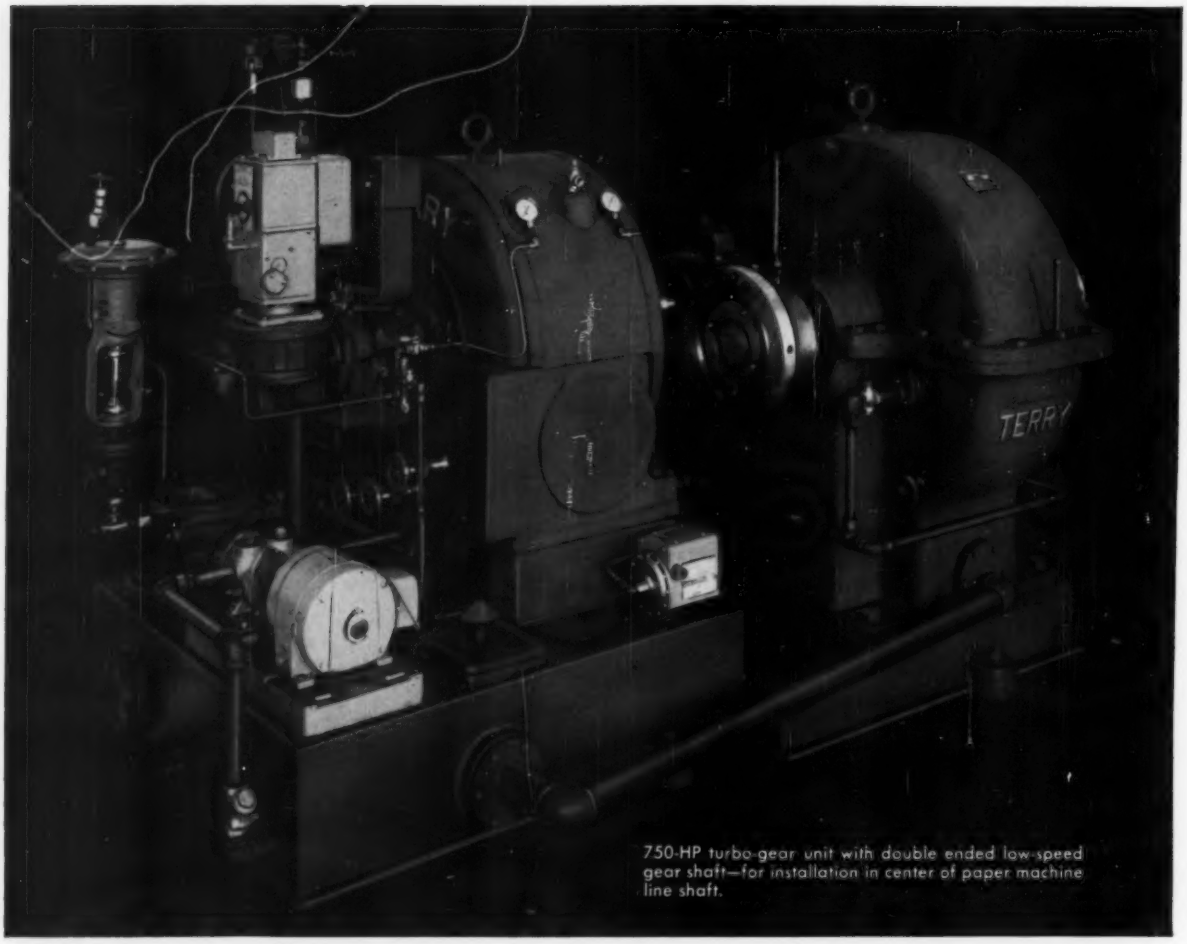

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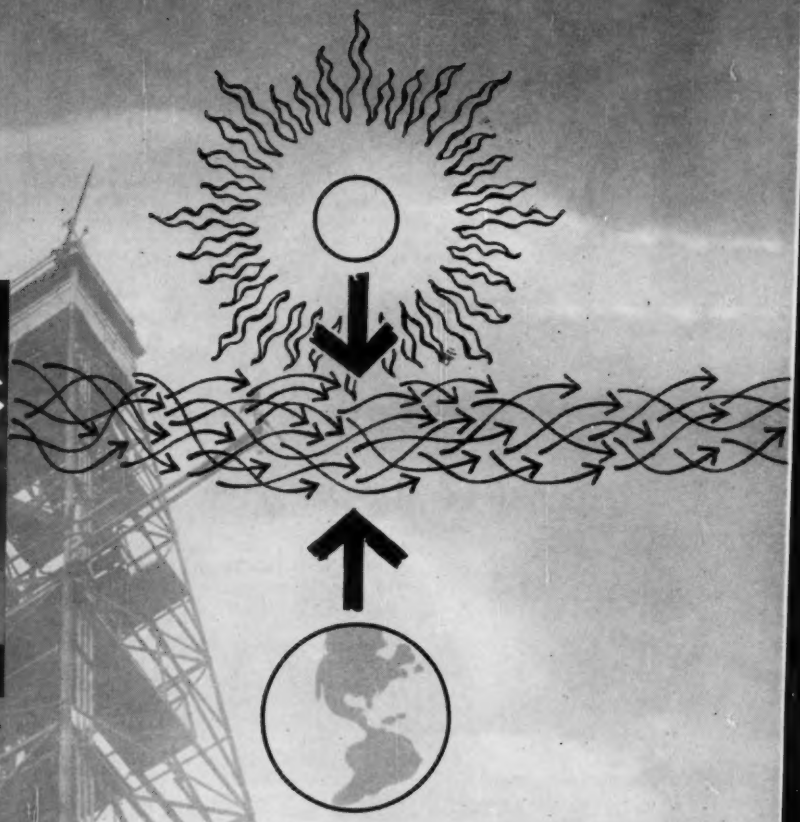
Multiple exposure photograph of a smoke plume from the Meteorology experimental stack.



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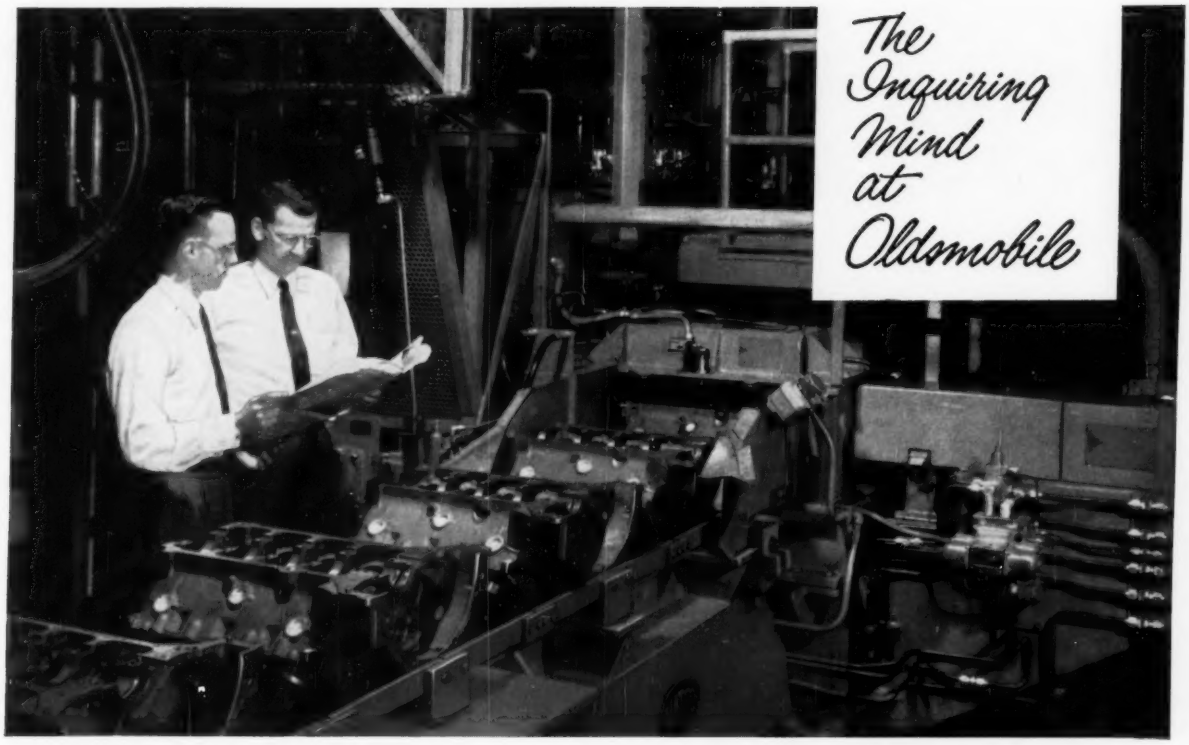

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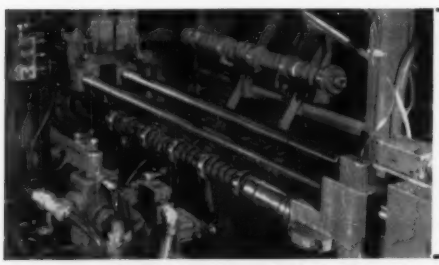

◀ Camshaft is rotated and lubricated as it automatically slides into engine block.

Scarred lobe on camshaft ▶ indicates scored bearing and may result in shorter camshaft and bearing life.

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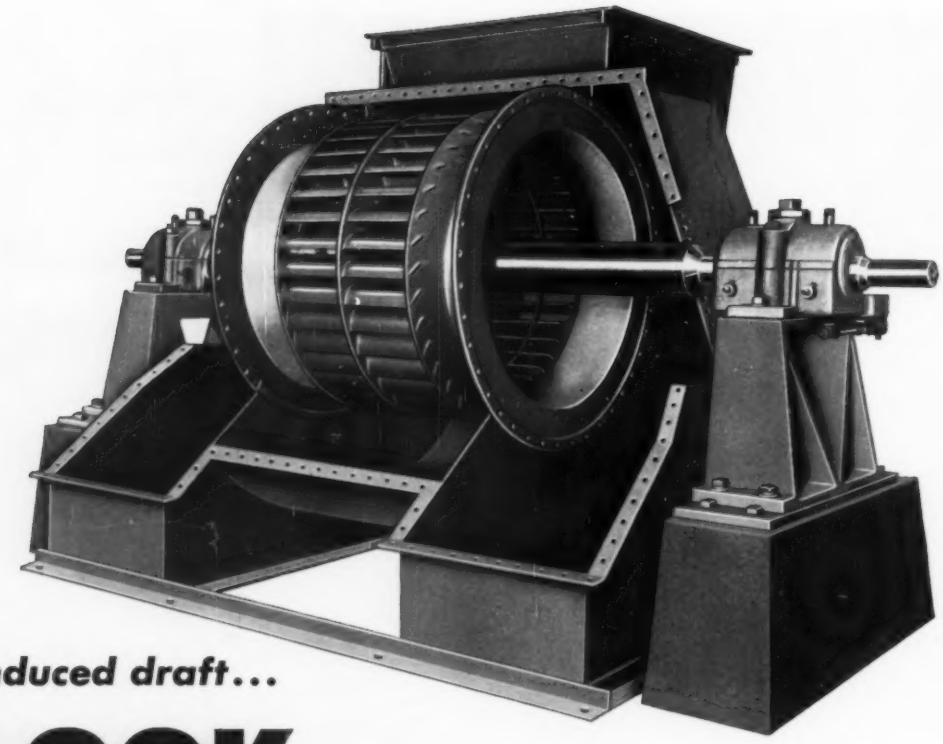

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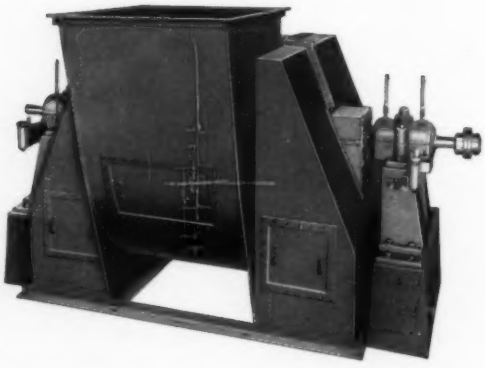

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Heat Transfer and Fluid Flow: Steady-state and transient analysis. Includes power optimization studies, free and forced convection flow transients, boiling, and two phase flow. Advanced analytical methods using analog and digital computers.

Stress Analysis: Structural, thermal, and dynamic stress analysis of high temperature reactor systems.

Systems Analysis: Coordinate engineering on reactor plant design.

Control Analysis: Reactor kinetics and overall nuclear power plant control – hazard analysis – analog and digital computers.

Operations: Foreign and domestic – for check-out, start-up and customer training. Includes operational analysis and design criteria.

DEVELOPMENTAL

Requires related experience and applicable degree.

Fuel Elements: Experienced senior physical metallurgists for responsible positions in nuclear reactor fuel development programs. Includes studies of radiation effects, overall evaluation of uranium and thorium alloy, and ceramics. Also metallurgical engineers for mechanical fabrication development for these materials.

Mechanical Components: Experienced mechanical engineers for the development of coolant and other equipment for power reactors. Stimulating developmental problems in thermodynamics, stress, heat transfer and fluid dynamics. Senior metallurgists for responsible research positions on reactor structural materials. Desire alloy development and solid state diffusion experience.

Instrumentation and Control: Senior physicists and EE's for design and development of advanced design transistor, vacuum tube, and/or magnetic amplifier control and instrumentation components.

DESIGN

Senior opening. Degree required. Nuclear experience essential.

Process Instrumentation: Reactor, auxiliary, and control systems.

Facilities: Mechanical systems.

Process Systems and Equipment: Pumps, heat transfer equipment.

Electrical: Reactor control and power systems.

Machine Design: Heavy mechanical.

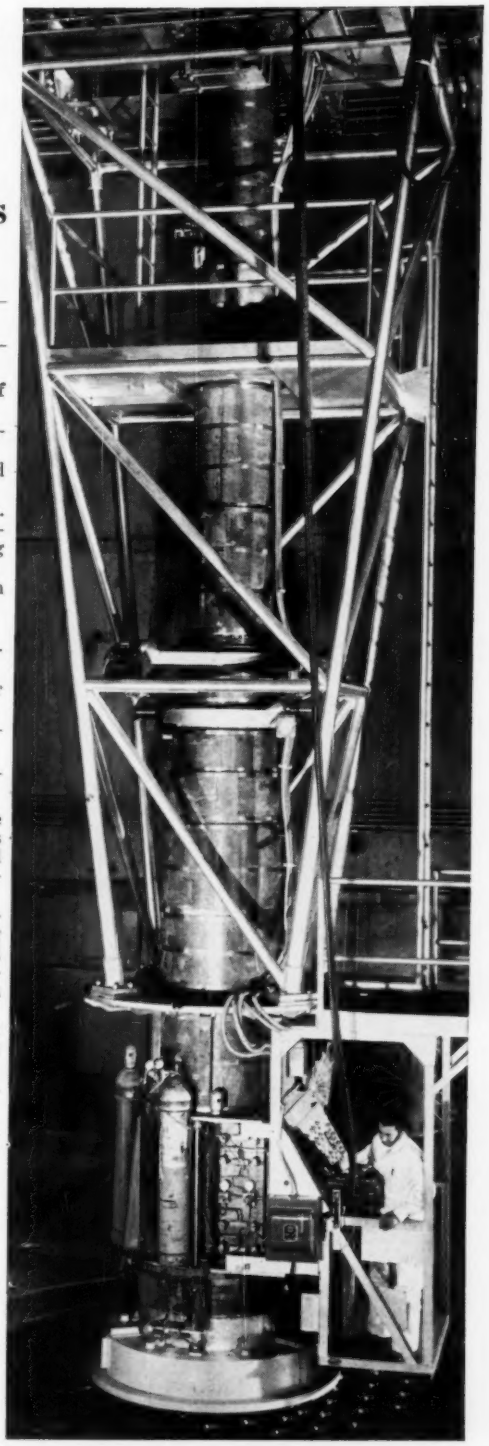
Reactor Core Components: Moderator cans, fuel elements, core supporting structures.

Control Mechanisms: Control and safety rods, drives and allied tooling.

Other opportunities in:
Reactor Theory, Experimental Neutron Physics,
Solid State Physics, and Reactor Kinetics.

Write for more details of exciting career opportunities at AI.
Mr. A. G. Newton, Personnel Office, Atomics International,
15330 Raymer Street, Van Nuys, California.
(In the suburban San Fernando Valley, near Los Angeles)

ATOMICS INTERNATIONAL
A DIVISION OF NORTH AMERICAN AVIATION, INC.
PIONEERS IN THE CREATIVE USE OF THE ATOM



SRE Fuel Handling Cask. The Sodium Reactor Experiment and the Organic Moderated Reactor Experiment are both in successful operation. Plans for several central station plants based on these experimental power reactors are underway. AI is also conducting an advanced power reactor study for Southwest Atomic Energy Associates. Overseas, AI has already sold 5 reactors, and is affiliated with ASEA of Sweden and the new company INTERATOM (with DEMAG, West Germany).

TO THE MEMBERS OF———

THE AMERICAN SOCIETY OF MECHANICAL ENGINEERS

Members of the ASME are invited to name any number of engineers as candidates for membership. Engineering acquaintances should be qualified by both fundamental training and experience for one of the technical grades. Those who do not have an engineering degree may show the equivalent thereof through actual practice. Executives of attainment in science or industry may associate with the Society as Affiliates.

THE American Society of Mechanical Engineers promotes Mechanical Engineering and the allied arts and sciences, encourages original research, fosters engineering education, advances the standards of engineering, promotes the intercourse of engineers among themselves and with allied technologists; separately and in cooperation with other engineering and technical societies, and works to broaden the usefulness of the engineering profession.

As a post graduate school of engineering, the Society brings engineers into contact with each other, with leaders of thought and with new developments; it fosters the interchange of ideas, develops professional fellowships, and encourages a high standard of professional conduct—all with the purpose of advancing civilization and increasing the well-being of mankind.

O. B. Schier, II, Secretary
The American Society of Mechanical Engineers
29 West 39th Street, New York 18, N. Y.

Date.....

Please send an application and information regarding ASME to the following:

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(3) Name.....
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Member's Name.....
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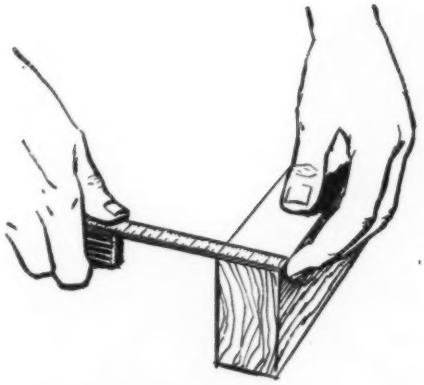
ME-7-58



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YES! DIMENSION and QUALITY of redwood are the obvious and fundamental cornerstones on which long service life and low maintenance costs must rest. They are your ONLY protection against delignification or chemical attack! Coupled with proper wood preserving treatment, they provide the necessary safeguards even in those areas where biological attack is prevalent.

COMPARE WHEN YOU BUY — AND INSIST ON GETTING THESE FOSTER WHEELER STANDARDS

THICKNESS COMPARISON OF IMPORTANT TOWER COMPONENTS

TOWER COMPONENTS	FOSTER WHEELER	MANUFACTURER "A"	MANUFACTURER "B"
SPLASH BARS	1"	1"	3/8"
FILL DECK SUPPORTS	2"	1"	1/2"
WATER DISTRIBUTION SYSTEM	2"	1"	1"
FAN STACK SHEATHING	1 1/2"	1"	3/8"
AIR INLET LOUVERS	1"	1/2"	1/2"
DRIFT ELIMINATOR BLADES	9/16"	7/16"	5/16"

"To conserve water is good business . . . for you, your neighbor, and the Nation."

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FOSTER WHEELER

NEW YORK • LONDON • PARIS • ST. CATHARINES, ONT.

STRAIGHT TALK TO ENGINEERS

from Donald W. Douglas, Jr.

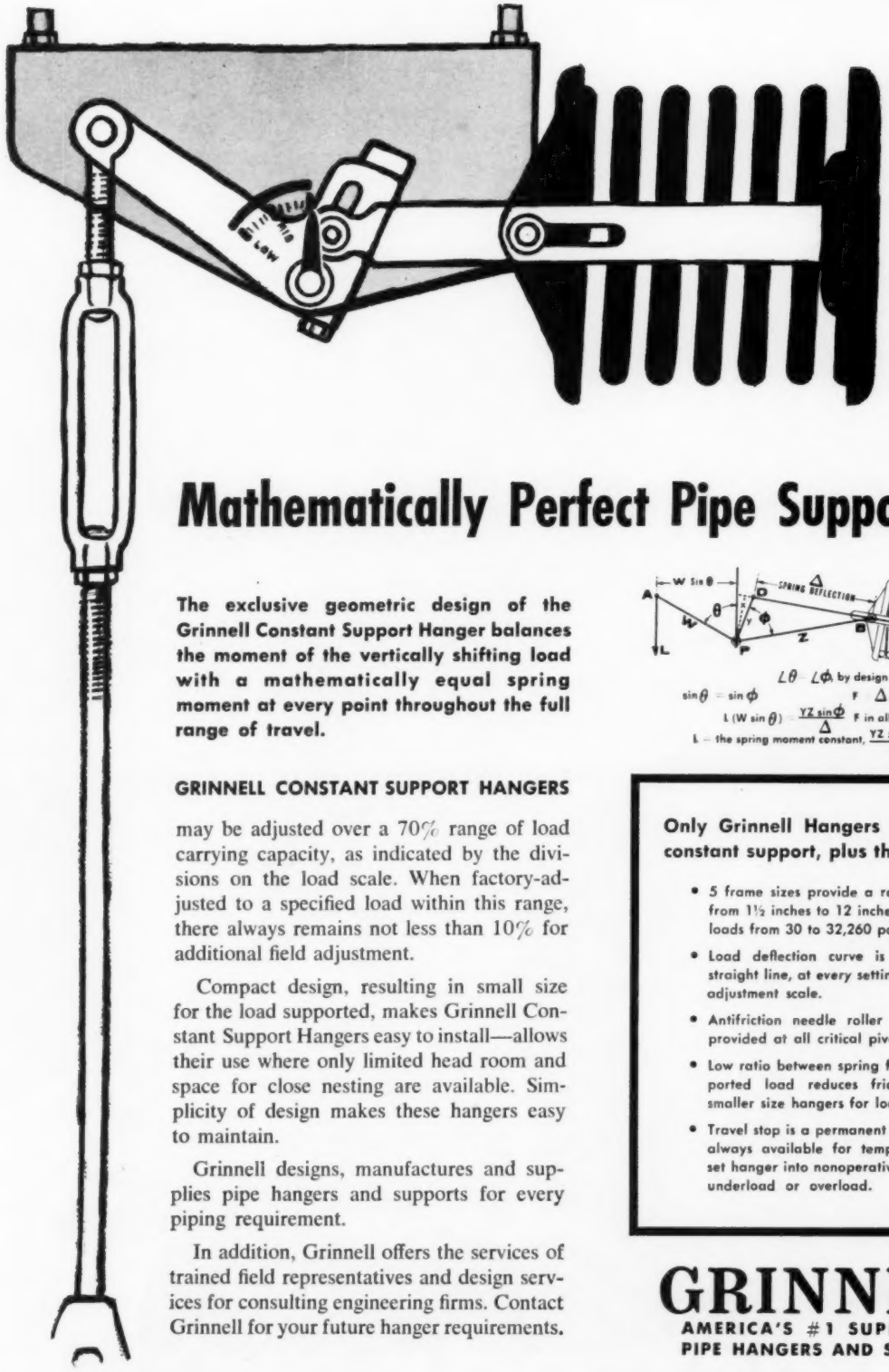
President, Douglas Aircraft Company

In your field, as most of you well know, it's easy to be complicated . . . it's hard to be simple. At Douglas, I'm happy to say, we do things the "hard" way. This matter of simplicity is vitally important. We work intensive hours, days and months to achieve it.

Why this extra effort? Well, simple things work easier, last longer, are more easily maintained and are lots more reliable. We are rewarded for our greater engineering effort with a product that performs better for our various customers.

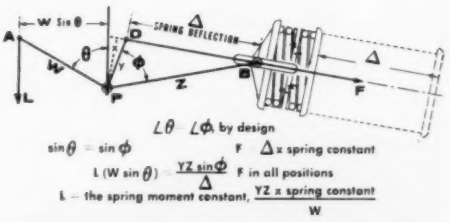
We know that good engineers, working in an atmosphere which stimulates them to do their best, have been largely responsible for our success. If you enjoy solving challenging problems in the simplest manner, we'd like to talk with you about joining us.

Please write to Mr. C. C. LaVene
Douglas Aircraft Company, Box K-620
Santa Monica, California



Mathematically Perfect Pipe Support!

The exclusive geometric design of the Grinnell Constant Support Hanger balances the moment of the vertically shifting load with a mathematically equal spring moment at every point throughout the full range of travel.



$\angle\theta \quad \angle\Phi$ by design

$\sin\theta = \sin\Phi$ $\quad F \quad \Delta \times$ spring constant

$L\,(W \sin\theta) \quad \frac{YZ \sin\Phi}{\Delta} \quad F$ in all positions

L = the spring moment constant, $\frac{YZ \times \text{spring constant}}{W}$

GRINNELL CONSTANT SUPPORT HANGERS

may be adjusted over a 70% range of load carrying capacity, as indicated by the divisions on the load scale. When factory-adjusted to a specified load within this range, there always remains not less than 10% for additional field adjustment.

Compact design, resulting in small size for the load supported, makes Grinnell Constant Support Hangers easy to install—allows their use where only limited head room and space for close nesting are available. Simplicity of design makes these hangers easy to maintain.

Grinnell designs, manufactures and supplies pipe hangers and supports for every piping requirement.

In addition, Grinnell offers the services of trained field representatives and design services for consulting engineering firms. Contact Grinnell for your future hanger requirements.

Only Grinnell Hangers provide true constant support, plus these features:

- 5 frame sizes provide a range of travel from 1½ inches to 12 inches and support loads from 30 to 32,260 pounds.
- Load deflection curve is a horizontal straight line, at every setting on the load adjustment scale.
- Antifriction needle roller bearings are provided at all critical pivot points.
- Low ratio between spring force and supported load reduces friction, permits smaller size hangers for loads carried.
- Travel stop is a permanent attachment — always available for temporary use to set hanger into nonoperative position for underload or overload.

GRINNELL

AMERICA'S #1 SUPPLIER OF PIPE HANGERS AND SUPPORTS

Grinnell Company, Inc., Providence, Rhode Island • Coast-to-Coast Network of Branch Warehouses and Distributors

pipe and tube fittings • welding fittings • engineered pipe hangers and supports • Thermolier unit heaters • valves
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YOU don't have to make unnecessary, costly compromises in selecting drying equipment. Drying standards set in development stages can be duplicated in your pilot plant and in full production operations when you use Lectrodryers.

Lectrodryer makes a more complete line . . . more carefully tailored-to-need . . . than any other manufacturer. We can meet your requirements *exactly* . . . supply the type and size drier you need at all stages . . . from test tube to mass production. Consistently efficient, low-cost adsorbent drying is assured with a full line of job-matched Lectrodryers.

This is another reason *leading industries look to* Lectrodryer. For help in dryness engineering call or write Pittsburgh Lectrodryer Division, McGraw-Edison Company, 305 32nd Street, Pittsburgh 30, Pennsylvania.

Tiny 45-pound laboratory Lectrodryer sets process standards of drying.

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Leading industries look to

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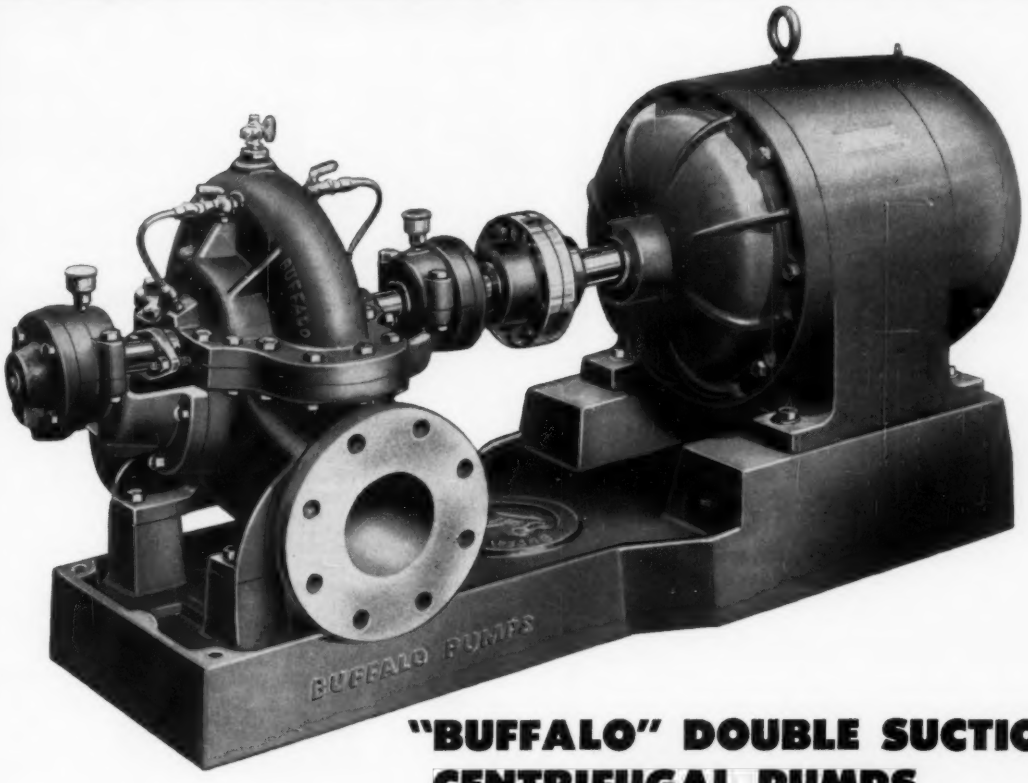


"BUFFALO" DOUBLE SUCTION CENTRIFUGAL PUMPS

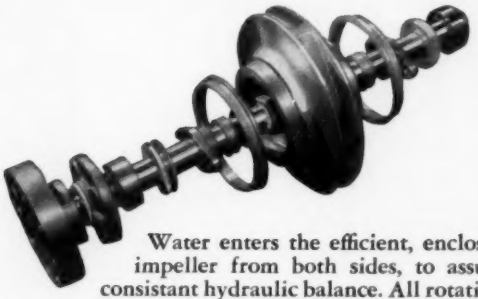
OFFER MORE FOR YOUR PUMP DOLLAR

- **Long Life**
- **High Efficiency**
- **Quiet Operation**
- **Reliability**
- **Minimum Down Time for Repairs**
- **Availability of Replacement Parts**

"Buffalo" Pumps' engineering and rugged, dependable construction make them highly desirable for demanding industrial service. For example, "Buffalo" Double Suction Pumps for dependable clear water service feature precision-machined casings with ample water passages — impellers designed for highest efficiencies — bronze wearing rings — sturdy shafts and heavy-duty ball bearings.

The complete line of "Buffalo" Double Suction Pumps, in capacities from 10 to 14,000 gpm, assures the pump that's tailored to *your* clear water moving needs — *exactly*. For full information, contact your nearby "Buffalo" Engineering Representative, or write for Bulletin 955-R.

Value Beneath the Surface . . . the impeller and shaft assembly of the "Buffalo" Double Suction Pump.



Water enters the efficient, enclosed impeller from both sides, to assure consistant hydraulic balance. All rotating elements are carefully-balanced prior to assembly.

The value "bonus" in every "Buffalo" Pump is the "Q" Factor — the built-in QUALITY which assures trouble-free satisfaction and long life.

"Buffalo" PUMPS

BUFFALO PUMPS

DIVISION OF BUFFALO FORGE CO.

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Sales Representatives in all Principal Cities

A BETTER CENTRIFUGAL PUMP FOR EVERY LIQUID

"MONOBALL"®
Self-Aligning Bearings

CHARACTERISTICS

	ANALYSIS	RECOMMENDED USE
1	Stainless Steel Ball and Race	For types operating under high temperature (800-1200 degrees F.).
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Thousands in use. Backed by years of service life. Wide variety of Plain Types in bore sizes 3/16" to 6" Dia. Rod end types in similar size range with externally or internally threaded shanks. Our Engineers welcome an opportunity of studying individual requirements and prescribing a type or types which will serve under your demanding conditions. Southwest can design special types to fit individual specifications. As a result of thorough study of different operating conditions, various steel alloys have been used to meet specific needs. Write for revised Engineering Manual describing complete line. Dept. ME-58.

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For Industrial Engine Application

One Lever DOES IT ALL
CONTROLS SPEED AND DIRECTION OF TRAVEL

- NO GEAR SHIFTING
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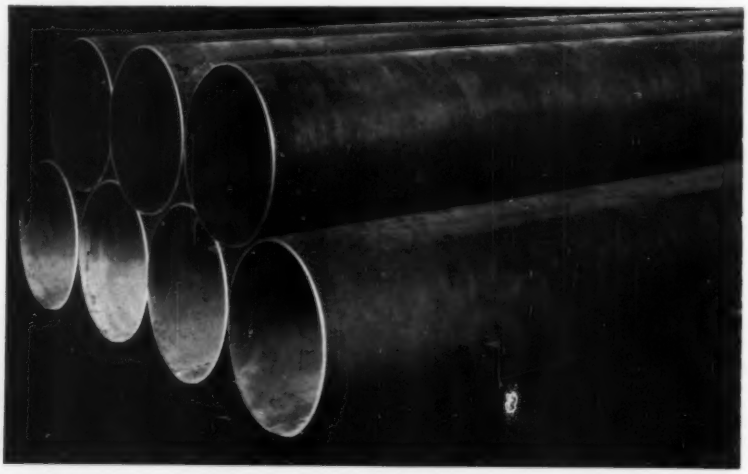
HYDRAULIC CONTROLLED REVERSING CLUTCH with TORQUE CONVERTER

Incorporate FUNK'S REVERS-O-MATIC in your moving equipment for maximum efficiency. Speed and direction of travel – forward and reverse or lift and lower – can be easily controlled with ONE LEVER or foot pedals. Converter eliminates shock and multiplies engine torque more than 200% to broaden the h.p. range.

Our Standard Flange System affords unlimited combinations of FUNK MODULAR POWER UNITS. Let FUNK Engineers make specific recommendations.

FUNK MFG. CO.
Box 577-E
Coffeyville, Kansas

Large O.D. ALLOY PIPE



fabricated to meet your requirements

For high pressure, high temperature water lines . . . for sewage outfall lines . . . for any job requiring fabricated steel pipe of 14" O.D. or larger . . . you can depend on Posey's many years of engineering and manufacturing experience and complete production facilities. Write, wire or phone for information without obligation.

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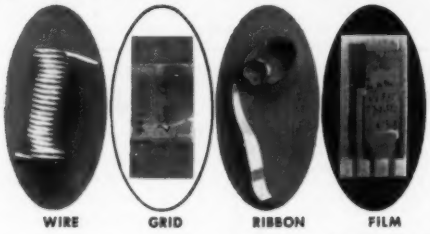
NOW DUCTILE BISMUTH
in wires, grids, ribbons and films!



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At last you can take advantage of Bismuth's extreme sensitivity to changes of temperature and magnetic field intensity. Through an exclusive process, we have perfected Bismuth in ductile form . . . Bismuth that can be bent without crumbling and breaking. Available in insulated or bare wires, in special alloys for thermocouple legs, in wire form or grids for resistance controlled circuits and gauss meters, and in ribbons or plastic mounted films for Hall effects. No other material is so versatile in its application to control and testing instrument design.

HAS 1001 USES IN TESTING AND CONTROL INSTRUMENTS!

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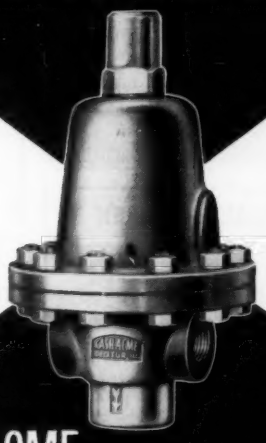
THE TREND
IN DRAFTING ROOMS THROUGHOUT THE WORLD IS TOWARD IMPERIAL, THE WORLD'S FINEST
TRACING CLOTH

CASH-ACME . . . meeting pressure control needs for product design engineers everywhere



Type FR Back Pressure Valve

CASH-ACME SPECIAL BY-PASS VALVE HELPS AIR FORCE LICK ICE PROBLEM IN ARCTIC

The greatest potential "saboteur" at Strategic Air Force Command bases in the Arctic is ICE. That's why mobile de-icers are as highly prized as radar.

In perfecting modern de-icing equipment, air force designers received an invaluable assist from Cash-Acme engineers. Since ordinary valves and liquids are completely inoperative at 65° below zero, new methods were urgently needed. With the help of Cash-Acme Back Pressure Valve (Type FR)—specially modified for this extremely rigorous job—a unique sprayer was developed for discharging ethylene glycol.

Using high pressure spray nozzles to thaw out iced-up areas, crewmen keep jet bombers and interceptors ready for instant take-off.

TYPE FR BACK PRESSURE VALVE

Ready for tough, exacting jobs anywhere. Automatically controls desired maximum pressure by maintaining a determined inlet pressure at valve and relieving into a low pressure line. Readily usable for all liquids and gases. Slight modifications make it useful as a differential pressure regulator. For Answers to Pressure Control Problems in Your Product.

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positions open • positions wanted • equipment, material, patents, books, instruments, etc. wanted and for sale • representatives • sales agencies • business for sale • partnership • capital • manufacturing facilities

ANSWERS to box number advertisements should be addressed to given box number, care of "Mechanical Engineering," 29 West 39th St., New York 18, N. Y.

RATES: Classified advertisements under this heading in MECHANICAL ENGINEERING are inserted at the rate of $4.00 a line. $2.00 a line to members of ASME. Seven words to the line average. A box number address counts as one line. Minimum insertion charge, 5 line basis. Display advertisements carried in single column units of multiples of one inch at flat rate of $40.00 per inch per insertion. Copy must reach us not later than the 10th of the month preceding date of publication.

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MECHANICAL ENGINEER

For Assistant Superintendent of service engineering in large manufacturing plant, southern location. Should have degree in Mechanical Engineering. Prefer man with experience in operation and maintenance of steam and power generating equipment. Knowledge of electrical maintenance and construction would also be helpful.

Address CA-6501, % "Mechanical Engineering."

SALES ENGINEERS WANTED

for Chicago and Houston. Prefer men with Electrical, Mechanical or Chemical Engineering degrees. Successful applicants will receive three months' intensive training at factory in Waterbury, Connecticut before assignment to district office. Prefer men between 25 and 30 who can start as trainees. Previous sales and instrument experience desirable but not mandatory. Those interested in Chicago opening address reply to S. E. Gewin, District Manager, The Bristol Company, 351 E. Ohio Street, Chicago 11, Illinois. Those interested in Houston opening address reply to E. A. Merwin, District Manager, The Bristol Company, 3617 W. Alabama, Houston 6, Texas.

PROJECT ENGINEER

Wanted by manufacturer of Pulp and Paper Mill machinery for work in Research and Development. Must be a graduate mechanical engineer with a minimum of five years' experience, including at least two years in machinery design, preferably in the Pulp and Paper industry—New England location. Give detailed resume of experience.

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Aggressive Research, Development and Selling have made Edward Valves, Inc., a leader in the steel valve industry. We are expanding our staff and facilities to maintain this position. Have opportunities for—

Engineers (mechanical stress, flow, materials, metallurgical) interested in design and development of valves for high pressure, high temperature service and nuclear power applications.

Sales Engineers—Recent Engineering graduates, preferably M.E. for approximately one year inside sales training prior to assignment to a territory.

Send complete resume in confidence.

EDWARD VALVES, INC.
Subsidiary of Rockwell Manufacturing Co.
1200 W. 145th Street, East Chicago, Indiana
Mr. E. A. Loeser, Engineering Personnel

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To work on heat transfer, thermodynamics and hydrodynamics of atomic reactors and associated components for power generation. Expanding department of well established upstate New York manufacturer provides excellent potential for well-qualified personnel. Company's ability to produce is proven by the Army Package Power Reactor Plant completed on time and now operating routinely.

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ALCO PRODUCTS, INC.
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with prominent paper manufacturer

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West Virginia Pulp and Paper Company, one of the nation's leading multi-plant manufacturers of paper and paper products, is organizing an Equipment Engineering section to develop new production equipment. This unusual opportunity will call for bringing the results of research projects to commercial actuality, the advancement of present technology, and the improvement of existing equipment.

The men we are seeking will have a strong interest in high speed paper machinery and related operations . . . men who are willing to accept the challenge of developing the *new and unconventional*.

Recent graduates with strong fundamental backgrounds, as well as several men with proven experience in this field, are desired.

All inquiries will be considered promptly and held confidential. Please contact:

Director of Research and Development
West Virginia Pulp and Paper Company
Covington, Virginia

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Requires B.S., M.E. or E.E. with 3 to 5 years' experience in dynamic analysis and synthesis of servo systems using analog computers as an aid. Prefer direct experience with hydraulic and pneumatic systems. Will work on analytical group assignments relating to dynamic systems' analysis and synthesis on high-pressure electro-hydraulic devices, high-pressure pneumatic systems, jet engine fuel systems, etc.

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Senior Project Engineer is required to organize and assume charge of a small group engaged in the development of airborne equipment for the generation and use of high-pressure gas from cryogenic liquids, which will be used for control and actuation of various devices on aircraft and missiles.

Responsibility will include proposal and cost-estimate preparation, project planning, engineering coordination with customers, supervision of design and analytic work, development of low-temperature components, planning for laboratory test facilities, production support activity, and all else necessary to carry a project from the preliminary concept through full qualification testing of flightworthy hardware.

Five to ten years' experience is required in this or related fields, with a good background also in the general area of thermodynamics and general physics, as well as in design and development work.

●

Modern plant located in suburban area offers ideal living conditions and excellent school facilities. Expanding company offers excellent opportunity for advancement.

Send resume detailing educational background and experience to:

Personnel Department
CHANDLER-EVANS DIVISION
PRATT & WHITNEY CO., INC.
West Hartford, Conn.

Qualified applicants will be invited to West Hartford plant for personal interview concerning these positions.

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Page reserved for advertisements to experienced engineering specialists to fill immediate openings. Standard units only.

Chief Engineer

$30,000

If you are a mechanical engineer and have had supervisory experience in the design and development of small precision mechanical or electrical products, this opportunity will have great interest for you.

Our company is a well established manufacturer with volume approaching $100,000,000 annually. We have excellent facilities and a history of creative achievement in product development.

Preferred age range is 30 to 50 years. Excellent incentive bonus, insurance and retirement programs.

You may discuss your qualifications with us in complete confidence. Please give present company, position, age, compensation and home telephone number.

Address CA-6499
% "Mechanical Engineering."

DESIGN ENGINEERS FOR ALUMINUM PRODUCT DEVELOPMENT

With design experience in the application of aluminum in architecture and construction, automotive, trucks and trailers, railway, marine, process industry appliances, etc., for work in the Aluminum Technical Center of Olin Mathieson Chemical Corp., New Haven, Connecticut. Pleasant living conditions, opportunities for advancement. Apply to

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New Haven, Connecticut

Opportunities Unlimited

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Under the auspices of the Four Founder Engineering Societies and affiliated with other renowned Engineering Societies, E.S.P.S. offers many years of placement experience in addition to world wide contacts.

Write for E.S.P.S. weekly Bulletin of Positions Available . . . See a partial listing of available positions in Personnel Section.

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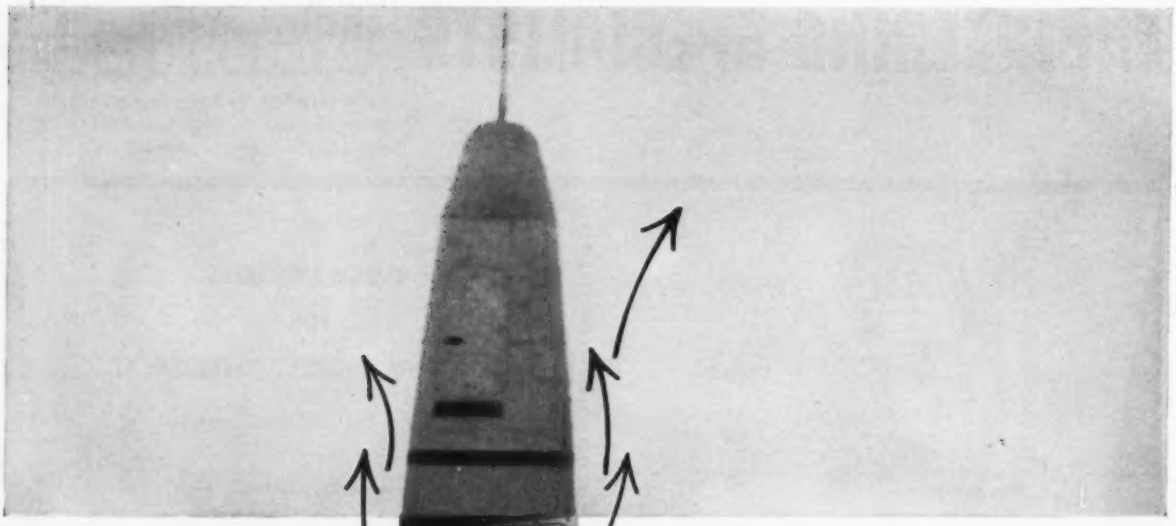
Offices In Major Cities In U. S.

New York	Chicago	Detroit	San Francisco
8 West 40th St.	84 East Randolph St.	100 Farnsworth Ave.	57 Post St.



you can only go . . . **UP** with ***missiles!***

Missiles are still in their infancy. And that precocious young child of the electronics industry—AC's Inertial Guidance System—offers one of the greatest opportunities in the entire field.
Why not go up and grow up . . . with AC and with missiles? You can work* with a team of engineering experts on AC's vital and far-reaching guidance systems. Or, you can exercise your talents on the development and production of many other electronic projects that make AC a new leader in the industry. What's more, you'll enjoy the stability and security and benefits that General Motors offers all their personnel.

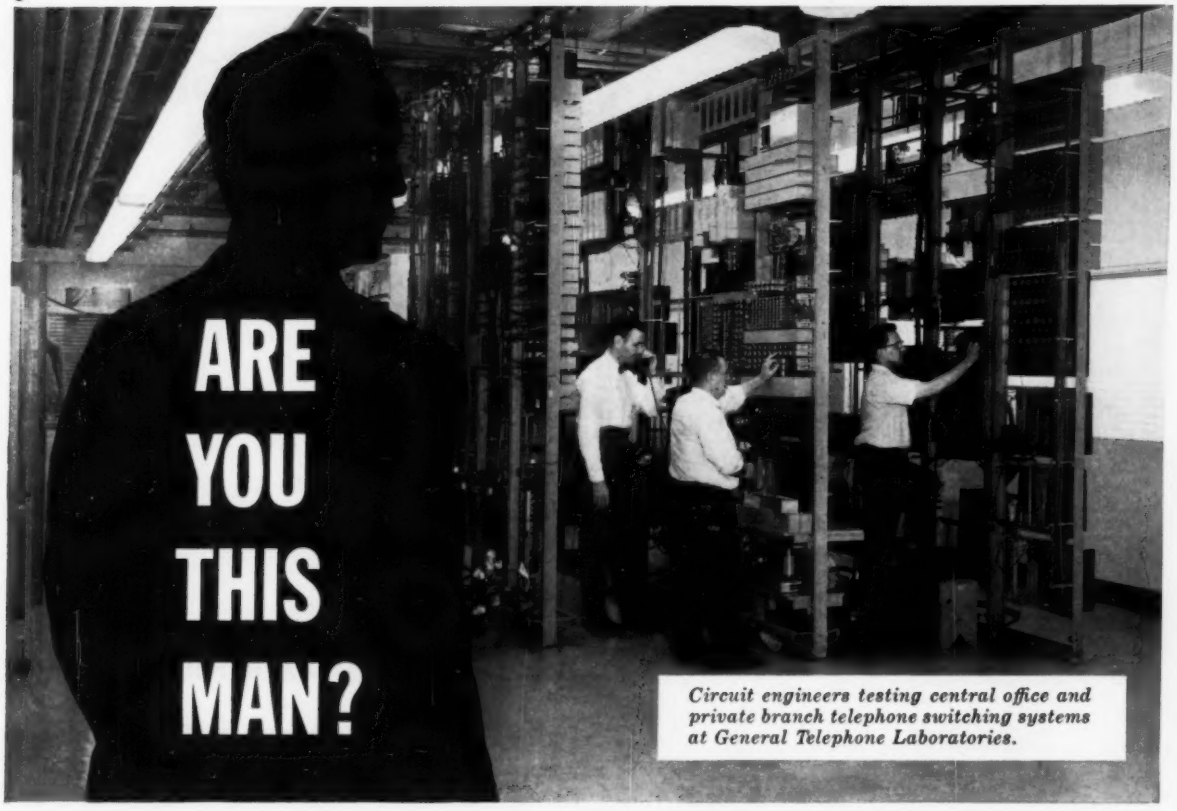
If this kind of opportunity intrigues you . . . and if you are a graduate engineer in the electronic, electrical or mechanical fields—or in gyroscope design . . . AC would like to hear from you. Your inquiry will receive an interesting response from Mr. Cecil E. Sundeen, Supervisor of Technical Employment, Dept. A, 1925 E. Kenilworth, Milwaukee 1, Wisconsin.

AC

AC SPARK PLUG ⚛ THE ELECTRONICS DIVISION OF GENERAL MOTORS

Producers of: AChiever Inertial Guidance Systems • Afterburner Fuel Controls • Bombing Navigational Computers Gun-Bomb-Rocket Sights • Gyro-Accelerometers • Gyroscopes • Speed Sensitive Switches • Speed Sensors • Torquemeters

The GENERAL Idea on Engineering Careers



Circuit engineers testing central office and private branch telephone switching systems at General Telephone Laboratories.

IF YOU are a man who has kept pace with the fast-moving art of telephony—and are qualified as a senior engineer—we have a challenging assignment for you at General Telephone Laboratories.

For example, working on the complex circuitry and high-speed switching involved in direct distance dialing. Not all of the problems have been solved. There's a big field for new ideas to meet the challenge of this latest marvel.

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But research and development in communications is only one phase of our work at General Telephone Laboratories. We also provide R & D support for our manufacturing affiliate, Automatic Electric, whose pioneering in automatic telephony was the forerunner of automated equipment so widely used throughout industry today.

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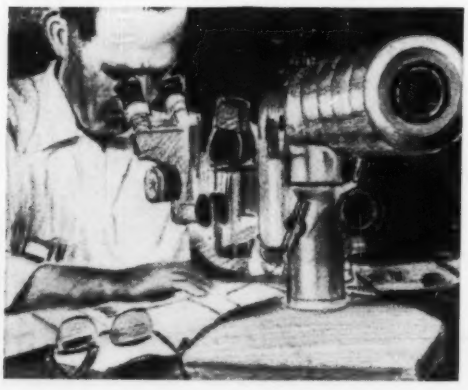

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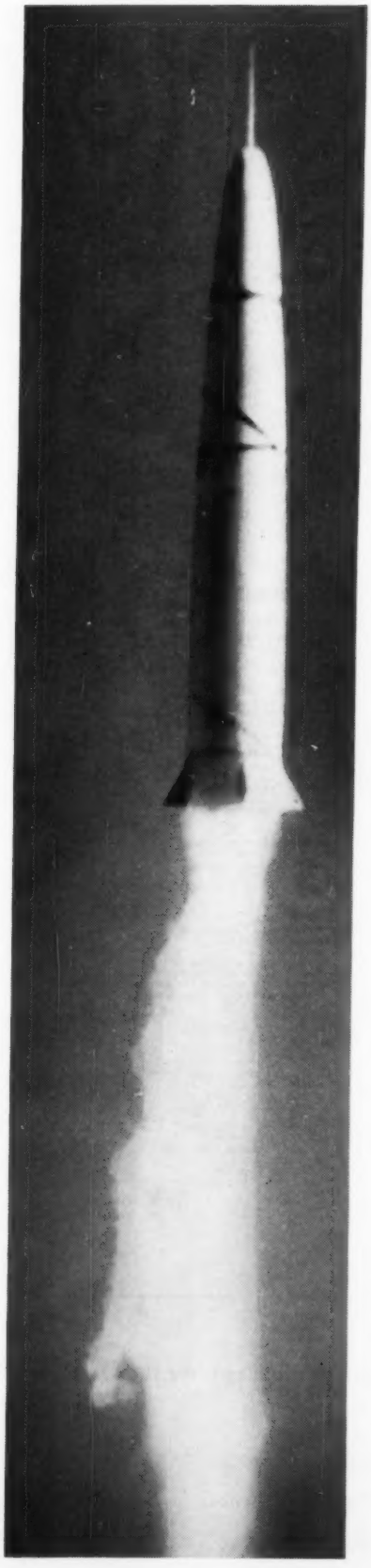

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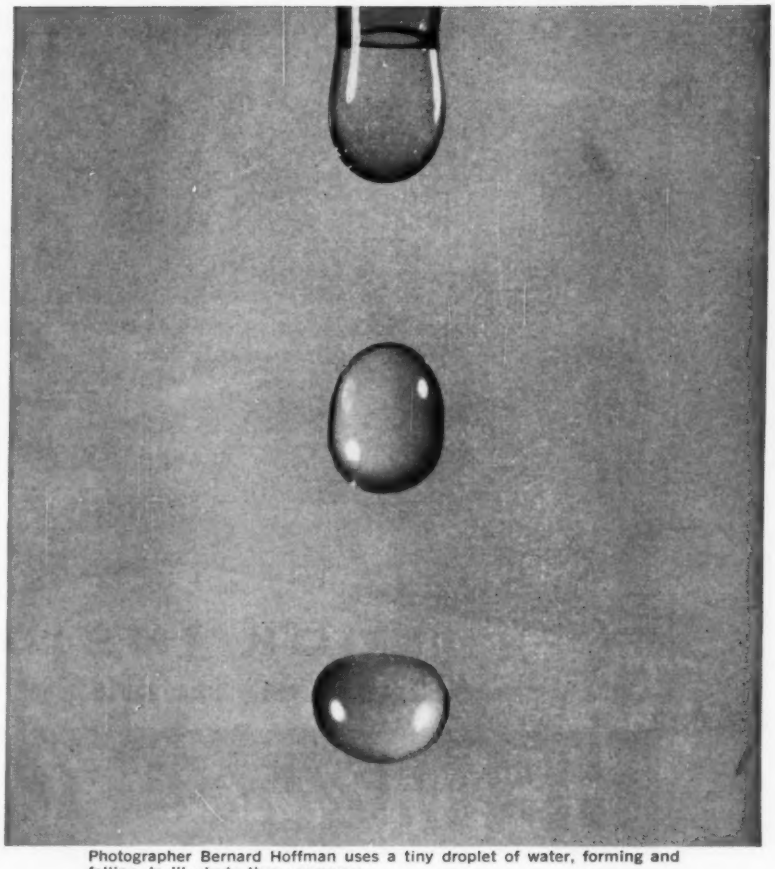

Photographer Bernard Hoffman uses a tiny droplet of water, forming and falling, to illustrate time sequence.

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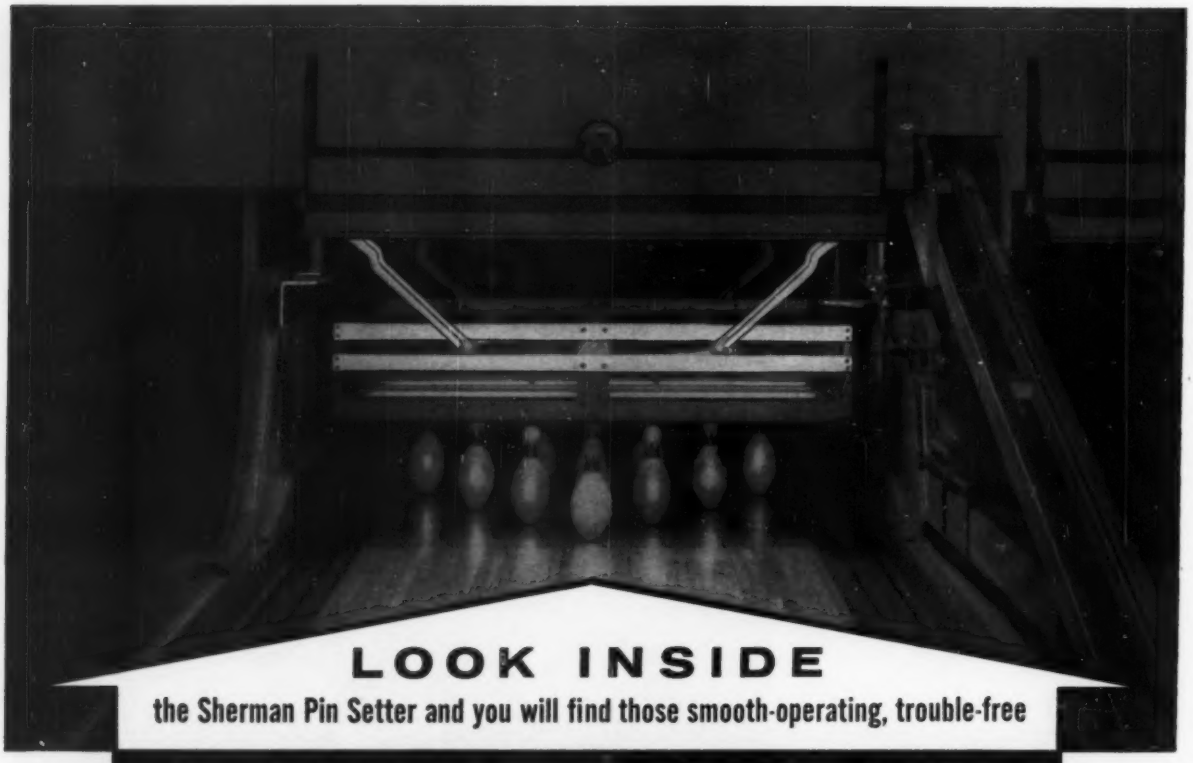

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the Sherman Pin Setter and you will find those smooth-operating, trouble-free

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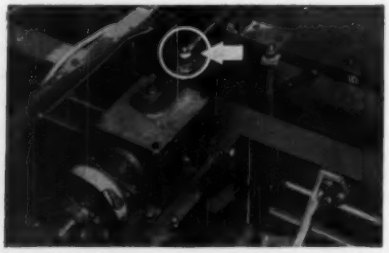
Photos taken at Johnson's Bowling Academy, Hamden, Conn.

HEIM UNIBAL ROD ENDS contribute trouble-free dependability to the push-pull rods on the distributor table drive assembly, and carry the full thrust load of the sweep drive assembly (the swinging arm which sweeps the alley clear of deadwood).

Distributor table drive assembly.

Sweep drive assembly.



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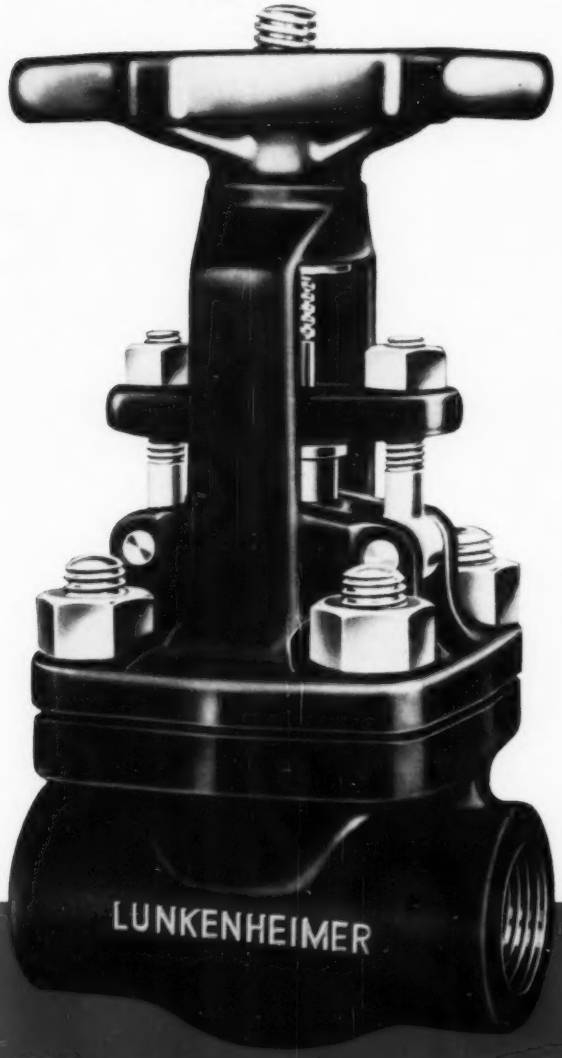

Another addition to the world famous line. In design, materials, and workmanship, this new Forged Steel Valve offers traditional Lunkenheimer performance to cut your maintenance costs to rock bottom. It's compact to fit cramped installation areas, without excess weight—yet safely handles high pressures and temperatures. Discs are 500 Brinell 13 Chrome Stainless Steel. Precision machined guides keep the disc from dragging across seat rings. Hardened 13 Chrome Stainless seat rings are rolled-in—never loosen in service. A two-piece gland of ball-and-socket design prevents binding in stuffing box.

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LUNKENHEIMER QUALITY

Fig. 8001

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Fig. 8001—Screw Ends, Sizes ½"—2"
Fig. 8002—Socket Welding, Sizes ½"—2".

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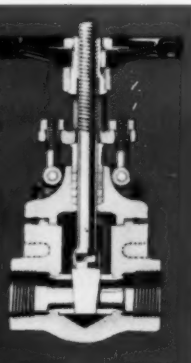

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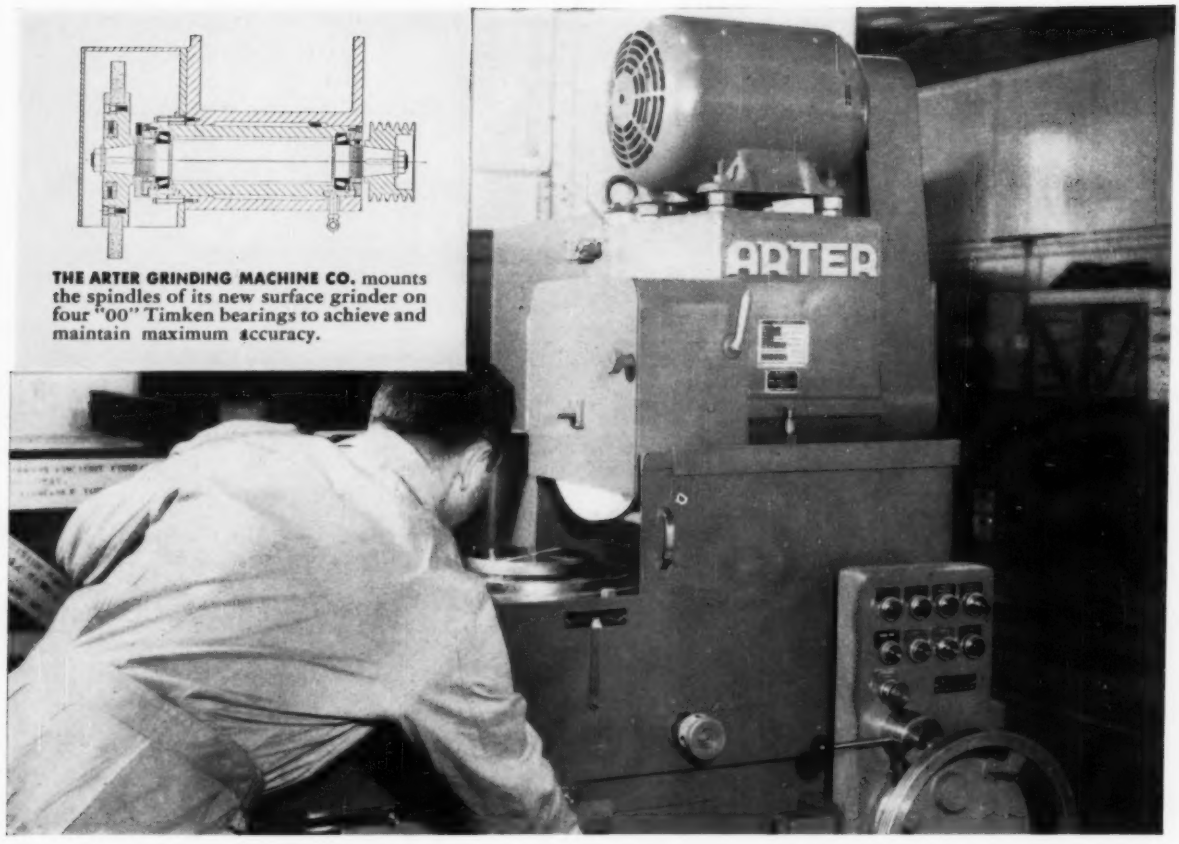

New precision grinder costs less to make, gives smoother spindle operation with TIMKEN® bearings

TO get the smooth spindle operation required for the extreme precision of their new surface grinder, The Arter Grinding Machine Company mounted the work spindle and the wheel spindle on four "00" Timken® tapered roller bearings. The extremely low run-out tolerances of Timken "00" bearings—75 millionths of an inch—make possible the closest machining tolerances ever achieved. And by using two Timken precision bearings on the spindle, Arter got greater capacity in less space—cut manufacturing costs ⅓ over earlier spindles used.

Timken "00" precision bearings not only deliver highest precision, but like all Timken bearings, they take both radial and thrust loads in any combination. And full line contact between Timken bearing rollers and races gives them extra load-carrying capacity. Shafts are held rigid — accuracy is maintained — gear life increased. Timken bearings run smoothly because they practically eliminate friction. They're designed by geometric law to have true rolling motion and precision manufactured to live up to their design. Normally last the life of a machine they're in.

The Timken Company developed "00" bearings to meet the demands of today's new precision machine tools. To produce these bearings, the Timken Company perfected measuring devices of unprecedented precision and developed new manufacturing techniques. The "00" bearing has achieved twice the precision of any previous Timken bearing.

Whatever machines you buy or build make sure your bearings are the best. Look for the trade-mark "Timken" on every bearing and be sure of maximum life, dependability, and minimum maintenance. The Timken Roller Bearing Company, Canton 6, Ohio. Canadian plant: St. Thomas, Ontario. Cable address: "TIMROSCO".

This symbol on a product means its bearings are the best.

TIMKEN

TRADE-MARK REG. U. S. PAT. OFF.

TAPERED ROLLER BEARINGS ROLL THE LOAD